

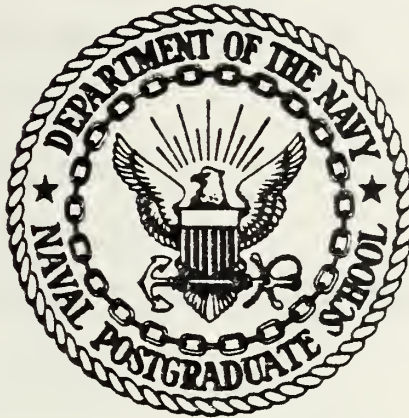
COASTAL CONTROLS ON VERTICAL
SOUND SPEED DETERMINATION AND
CORRECTIONS TO ECHO SOUNDINGS

David Winston Yeaeger

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THESIS

COASTAL CONTROLS ON VERTICAL
SOUND SPEED DETERMINATION AND
CORRECTIONS TO ECHO SOUNDINGS

by

David Winston Yeager

June 1979

Thesis Advisor

A. B. Chace, Jr.

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Examination of temperature and salinity data indicates that historical salinity values in the region are sufficiently stable to allow acceptable sound speed corrections to be made derived on the basis of in-situ temperature measurement and historically derived salinity values. Expendable bathythermograph probes are capable of meeting temperature requirements.

The constancy of the T-S relation in such regions may allow salinity determination from water temperatures alone.

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Coastal Controls on Vertical
Sound Speed Determination and
Corrections to Echo Soundings

by

David Winston Yeager
Lieutenant Commander, NOAA
B.S., Auburn University, 1970

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OCEANOGRAPHY (HYDROGRAPHY)

from the

NAVAL POSTGRADUATE SCHOOL
June 1979

ABSTRACT

Present methods for determining sound speed corrections for echo soundings in continental shelf areas are time-consuming and expensive. This study was undertaken to determine whether or not sound speed correctors of sufficient accuracy could be deduced from historical data.

Historical sound speed data for an east coast, shelf area indicates that temporal and spatial variability exceeds acceptable limits for sounding corrections, thus precluding the use of historical data only for corrector determination.

Examination of temperature and salinity data indicates that historical salinity values in the region are sufficiently stable to allow acceptable sound speed corrections to be made derived on the basis of in-situ temperature measurement and historically derived salinity values. Expendable bathythermograph probes are capable of meeting temperature requirements.

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TABLE OF CONTENTS

I.	INTRODUCTION - - - - -	9
	A. GENERAL - - - - -	9
	B. ACCURACY REQUIREMENTS - - - - -	11
	C. HISTORICAL TECHNIQUES - - - - -	12
	D. MEASUREMENT AND COMPUTATIONAL REQUIREMENTS-SOUND SPEED EQUATIONS - - - - -	15
II.	PROCEDURE AND METHODOLOGY - - - - -	20
	A. STUDY AREA - - - - -	20
	B. DATA SOURCE - - - - -	30
	C. TECHNIQUES FOR SUMMARIZING SOUND SPEED DATA - - - - -	31
	D. COMPUTER PROCESSING - - - - -	34
	E. PROCEDURE - - - - -	40
III.	DISCUSSION OF RESULTS - - - - -	46
IV.	CONCLUSIONS - - - - -	54
APPENDIX 1: COMPUTER PROGRAMS AND DOCUMENTATION - - -		58
APPENDIX 2: VELDAT, SALDAT AND TEMDAT RESULTS AND SEASONAL PROFILES - - - - -		104
APPENDIX 3: SEASONAL STATION PLOT - - - - -		122
BIBLIOGRAPHY - - - - -		126
INITIAL DISTRIBUTION LIST - - - - -		129
FORM DD 1473 - - - - -		1

LIST OF TABLES

I.	Temperature ($^{\circ}\text{C}$) in the Western North Atlantic - - -	27
II.	Salinity ($^{\circ}/_{\text{‰}}$) in the Western North Atlantic - - -	27
III.	Comparison of HIDAT Results with TEMDAT and SALDAT Results - - - - -	45
IV.	Summary of VELDAT RESULTS Region 1 - - - - -	47
V.	Variability of Sound Speed Temperature and Salinity - - - - -	51

LIST OF FIGURES

1.	Schematic Representation of BS ³ Sounding System Showing Swath Coverage	- - - - -	13
2.	Index Map of Study Area	- - - - -	21
3.	Surface Circulation in Study Area	- - - - -	24
4.	R/V GILL Station Plan	- - - - -	25
5.	Water Mass Distribution	- - - - -	29
6.	Sample NODCRD Output	- - - - -	36
7.	Sample Input Data Cards	- - - - -	38
8.	Regional Division of Study Area	- - - - -	42

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I. INTRODUCTION

A. GENERAL

The objective of this thesis was the application of basic oceanographic principles to the solution of an operational hydrographic problem. Depths determined by echo sounder are based on an assumed speed of sound in seawater. Corrections must be applied to such depths to account for the difference between the assumed and actual speed of sound. Present practice dictates that in-situ measurement of the sound speed profile in a working area be made and depth corrections computed. The problem is to determine if temporal and spatial sound speed variability in continental shelf areas is small enough to allow use of historical salinity and temperature data archived in the National Oceanographic Data Center's (NODC) Oceanographic Station File to correct echo soundings. Historical data was examined to determine whether or not correctors of sufficient accuracy could be obtained from historical data without resort to in-situ measurements.

Applicability of historical data (in the form of temperature and salinity measurements) has been widely discussed but limits of applicability have not been well-documented (Mobley, 1977).

This study was undertaken to examine the historical data available, its variability within a sample coastal region, and limitations on application in meeting National Ocean Survey (NOS) hydrographic requirements.

Echo Sounders (or fathometers) do not measure depth directly but rather measure the time delay between an outgoing sound pulse and the return echo of this pulse. Depth is then derived by dividing the round trip travel time by two and multiplying this value by the assumed speed of sound in seawater. The fathometer makes this transformation electronically or mechanically within the device itself and displays depth of water beneath the transducer. The depth displayed is the nominal or fathometer depth. True depth can be determined only if the soundspeed profile through the water column is known and used to calculate depth as in the following equation:

$$Z = \frac{1}{2} \int_0^{2\Delta t} V(Z_t) dt \quad (1)$$

"Where $V(Z_t)$ is the sound speed at the level Z_t where the signal passes at the time $0 < t < 2\Delta t$. Corrected depth is derived from nominal depth by applying a correction according to some standardized procedure" (Greenberg and Sweers, 1972).

Most echo sounders used in hydrographic surveying are constructed with a calibrated speed of sound assumed in the device. This speed is usually either 1463 meters per second (800 fathoms per sec) or 1500 meters per second (820 fathoms per second). Reference speeds are chosen to represent realistic ocean values which are convenient for design. Echo sounders in use by the National Ocean Survey at present are calibrated with an assumed sound speed of 1463 meters per

second. This value is reasonably near the actual speeds encountered in most waters surveyed by NOS (Umbach, 1976).

Sound speed corrections are applied to bring standardized values close to actual vertical column sound speeds for a location (Umbach, 1976).

Field measurements are made during the course of a survey in order to determine representative vertical sound speed profiles. These field measurements and their reduction are often time consuming, expensive and result in considerable conjecture regarding areas and times of corrector applicability.

B. ACCURACY REQUIREMENTS

The requirements for accuracy of echo soundings for hydrographic surveys are based on standards agreed to by member states of the International Hydrographic Bureau (IHB). Depth measurement requirements are stated in Special Publication 44, "Accuracy Standards Recommended for Hydrographic Surveys", published by the IHB in 1968. These standards vary with depth and may be summarized as follows (Umbach, 1976):

- (a) 0-11 fathoms - - - - - 1.0 ft.
- (b) 11-55 fathoms - - - - - 3.0 ft.
- (c) Deeper than 55 fathoms - - - - 1% of depth

These standards represent the maximum allowable errors in measurement of depth due to all sources, including variation of sound speed in the water column. "Accuracies attained for hydrographic surveys conducted by the National Ocean Survey shall equal or exceed those given by the IHB (Umbach, 1976)."

The National Ocean Survey's requirements for accuracy in determining the speed of sound for correcting echo soundings are stated as follows: "The velocity of sound must be known with sufficient accuracy to ensure that no sounding will be in error by as much as 0.25% of the depth from this cause alone. Therefore the mean velocity of sound must be known to within ± 4 meters per second" (Umbach, 1976). These standards apply only to conventional echo sounding systems and survey operations involving these systems. An implicit assumption is that the sound pulse or "beam" is vertical.

Future systems under test by NOS such as the BS³ (Bathymetric Swath Sonar System) will require greater accuracies. This is due to the fact that many beams are projected at varying angles through the water column to attain swath coverage. Figure 1 is a diagram of such a system. The longer acoustic path lengths, as well as varying trajectories, makes this technique more sensitive to sound speed error than present vertical depth measurements. Accuracy requirements for such a system have been stated as ± 2 meters per second (Mobley, 1977).

C. HISTORICAL TECHNIQUES

A brief review of historical techniques utilized by the hydrographer for determination of sound speed is necessary in order to properly appreciate the magnitude of the problem.

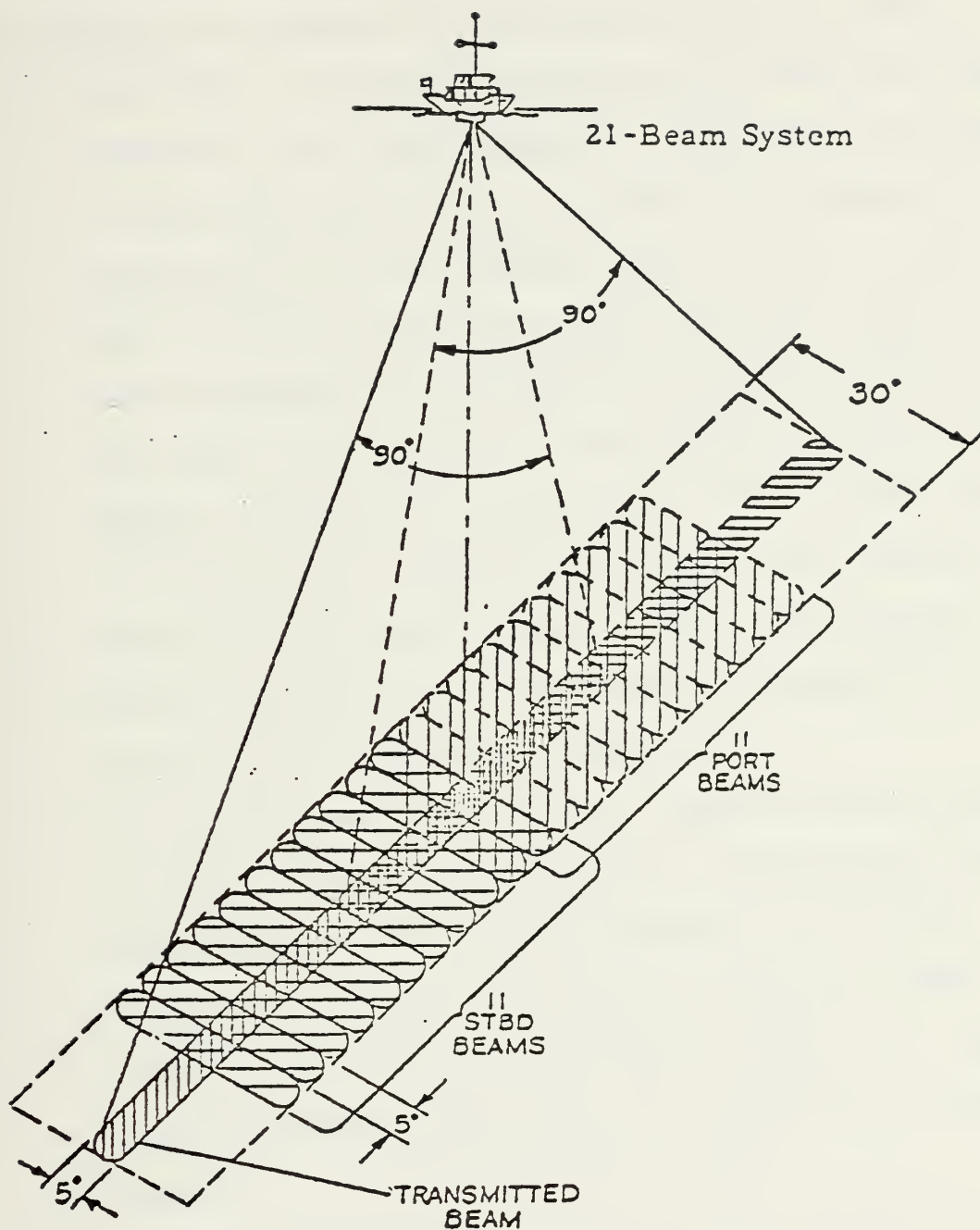


Figure 1
 Schematic Representation of BS³
 Sounding System Showing Swath Coverage
 (From Mobley, 1978)

There have been at least four common methods used to determine either the sound speed profile or the correction in depth units to be applied to soundings (Maunsell, 1976).

- 1) Bar checks or leadline comparisons in which the depth recorded by the echo sounder is compared to the depth of the reflecting surface of the "bar" lowered to a known depth, or the leadline depth to the bottom. This procedure has usually been limited to use in shallow depths due to problems of maneuvering the bar under the transducer, and correct gauging of the depths indicated by the leadline. This method gives a correction to be applied to the nominal depths indicated by the echo sounder. Sound speed may be determined from depth differences provided that draft of the transducer is known.
- 2) Direct measurement of salinity temperature and depth by either Nansen casts, salinity, temperature and depth sensors (STD) or the expendable STD (XSTD). Sound speeds at various standard depths are then computed using an equation relating salinity, temperature and pressure to speed, such as Wilson's 1960 equation.
- 3) Direct measurement of sound velocity as a function of depth by lowering a sound velocimeter to various depths and recording the speeds obtained at these depths. These devices have been poorly utilized in

the past due to design limitations. The development of an expendable Sound Velocimeter (XSV) makes this device promising for the future.

- 4) Historical tables or atlases of sound speeds or salinity and temperature data observed in the same area and season as the operations. Tables such as Matthews Tables (Matthews, 1939) and Heck and Service's Tables (Heck & Service, 1924) have been in use for quite some time with periodic efforts being made to improve upon the accuracy of results obtained (Ryan, 1974). These tables have not been generally applied to depths of 200 meters or less (Sherwood, 1974).

In general then, there have been a variety of methods employed, some utilizing direct measurement and others utilizing historical information. All of the methods summarized have been noted for deficiencies or disadvantages of one form or another. Adequate direct measurements of the sound speed profile in the operational area provide the best accuracy; however, in terms of expense and efficiency, there may be useable alternatives.

D. MEASUREMENT AND COMPUTATIONAL REQUIREMENTS - SOUND SPEED EQUATIONS

Sound speeds in a fluid may be calculated with various equations relating speed to density and elasticity of the medium. The following equation extracted from "Fundamentals of Acoustics" by Kinsler and Frey relates speed of sound in

a fluid to the isothermal bulk modulus (B_T), the ratio of specific heats (Γ) and density in kg/m^3 (ρ_0). Isothermal bulk modulus is an elastic modulus measuring the difficulty of compressing a liquid (Kinsler and Frey, 1962).

$$C = \sqrt{\frac{\Gamma B_T}{\rho_0}} \quad (2)$$

In the case of seawater, these properties are functions of salinity, temperature and pressure (Ryan, 1974).

Standard practice within the National Ocean Survey has been to use a form of Wilson's 1960 equation for the speed of sound as a function of salinity, temperature and pressure (Umbach, 1976). The usual case has been to calculate the in-situ speed profile from oceanographic observations within a project area. This empirical equation was developed as a "best fit" to certain measured data. The 1960 equation was an improvement over earlier versions in order to expand the range of applicability. The equation is stated by Wilson to fit data within the ranges of temperature from -4°C to 30°C , salinities from 0 ‰ to 37 ‰ and pressures between 1 kg/cm^2 and 1000 kg/cm^2 . This equation is said to have achieved a standard deviation of 0.30 meters/second from the mean for all data obtained (Wilson, 1960).

It has been noted by other researchers that significant accuracy improvements have been achieved in determining sound speeds utilizing equations that fit data limited to real

seawater conditions (LeRoy, 1969). One of the two equations formulated by LeRoy in 1968 "fit Wilson's second equation for seawater to within 0.1 meter/second in the domain described and the other fits Wilson's corresponding data with a better accuracy than does Wilson's equation" (LeRoy, 1969). Other equations such as those formulated by Frye and Pugh in 1971 also claim similar improvement (.1m/sec error estimate) (Frye and Pugh, 1971).

These variations are discussed as a means of pointing out possible error sources and improvements to techniques to achieve desired accuracies in sound speed determinations.

Wilson's 1960 equation is stated in the Journal of the Acoustical Society of America, October 1960 as follows:

$$\begin{aligned}
 V &= 1449.14 + V_T + V_P + V_S + V_{STP} \\
 V_T &= 4.5721T - 4.4532 \times 10^{-2} T^2 - 2.6045 \times 10^{-4} T^3 \\
 &\quad + 7.9851 \times 10^{-6} T^4 \\
 V_P &= 1.60272 \times 10^{-1} P + 1.0268 \times 10^{-5} P^2 \\
 &\quad + 3.5216 \times 10^{-9} P^3 - 3.3603 \times 10^{-12} P^4 \quad (3) \\
 V_S &= 1.39799(S-35) + 1.69202 \times 10^{-3} (S-35)^2 \\
 V_{STP} &= (S-35)(-1.1244 \times 10^{-2} T + 7.7711 \times 10^{-7} T^2 \\
 &\quad + 7.7016 \times 10^{-5} P - 1.2943 \times 10^7 P^2 + 3.1580 \times 10^{-8} PT \\
 &\quad + 1.5790 \times 10^{-9} PT^2) + P(-1.8607 \times 10^{-4} T \\
 &\quad + 7.4812 \times 10^{-6} T^2 + 4.5283 \times 10^{-8} T^3) \\
 &\quad + P^2(-2.5294 \times 10^{-7} T + 1.8563 \times 10^{-9} T^2) \\
 &\quad + P^3(-1.9646 \times 10^{-10} T).
 \end{aligned}$$

In this equation the units of temperature, pressure, salinity, and sound speed are °C, kg/cm², parts per thousand, and meters/sec, respectively. This equation is essentially the same as that given in the NOS Hydrographic Manual with the exception of the term containing variation of gravity with latitude. This term is used if pressure is not measured but computed from depth. The equation as stated in the Hydrographic Manual is:

$$V_u = 1449.14 + V_P + V_\phi + V_S + V_T + V_{STP} \quad (4)$$

"Where V_u is the speed of sound in meters per second, V_P is a correction for pressure, V_ϕ is a correction for variation of gravity with latitude, V_S is a correction for salinity, V_T is a correction for temperature and V_{STP} is a correction for the combined effect of salinity, temperature and pressure" (Umbach, 1976). All terms in equation 4 are the same as those in equation 3 with the exception of the V_ϕ term. V_ϕ may be determined by reference to tabulated values in Table 12C of Special Publication 68, "Handbook of Oceanographic Tables" published by the U.S. Naval Oceanographic Office in 1966.

It has been necessary to examine these equations in order to determine the effects which small variations in temperature or salinity have on the results attained.

As stated in the Hydrographic Manual, utilizing Wilson's Equation, temperature measurement accuracies of $\pm 1^\circ\text{C}$ and salinity measurement accuracies of $\pm 1\text{ppt}$ are required to satisfy sound speed correction requirements (Umbach, 1976).

An analysis of the Wilson equation was performed by Testing Division, Office of Marine Technology (OMT), NOAA in 1976 to determine sensitivity of the equation to variations of temperature and salinity (Bivins, 1976). Their results were stated as follows: "if corrections were made on the basis of temperature measurement with a one sigma (1σ) accuracy of $\pm 1^\circ\text{C}$, a natural variability of $\pm 3\text{ppt}$ (1σ) from the measured salinity could be tolerated and the NOS sound speed accuracy of ± 4 meters per second would be satisfied" (Bivins, 1976).

This analysis pointed out that the most critical measurement was temperature and if temperature accuracies of 1°C were met then salinity measurement errors within a larger range than previously noted could be tolerated.

The accuracy requirements, as well as the OMT analysis all bear on the acceptability of historical information for this application. In fact, the requirements stated are the criteria for acceptance or rejection of the technique proposed.

Sound speed corrections are computed within NOS by the "Summation of layers" method (Umbach, 1976). Once temperatures and salinities have been determined at standard depths, sound speeds at mid-layer depths are computed by graphical or numerical methods. These layer corrections are then summed to produce the total sound speed corrections applicable to given depths (Umbach, 1976). Layer thicknesses utilized in this procedure are specified in the "NOS Hydrographic Manual" as 10 meters for depths to 200 meters.

II. PROCEDURE AND METHODOLOGY

A. STUDY AREA

The area selected for study was a coastal region off-shore of Charleston, South Carolina. It was originally decided to examine a one-degree "square" extending from latitude 32°N to latitude 33°N and longitude 79°W to longitude 80°W. The study area was subsequently enlarged slightly in order to add additional data points near the northeast corner of the one-degree square. Figure 2 is an index map showing the study area.

The area was chosen on the basis of several factors:

First, it appeared to be representative of the oceanographic environments characteristic of east coast survey areas. The influx of estuarine waters in the nearshore area, bottom topography, depth range and other physical features are similar to those noted for shelf waters from Georgia to the Virginia Capes.

Second, the size of the region selected was typical of a one-year hydrographic project by a single coastal survey ship, or a six-month project by two ships.

Third, examination of the Environmental Data Service's "Key to Oceanographic Records Documentation No. 2, Temperature, Salinity, Oxygen and Phosphate in Waters off United States" showed the data density in this region to be representative of that in nearshore regions along the East Coast. Some 300

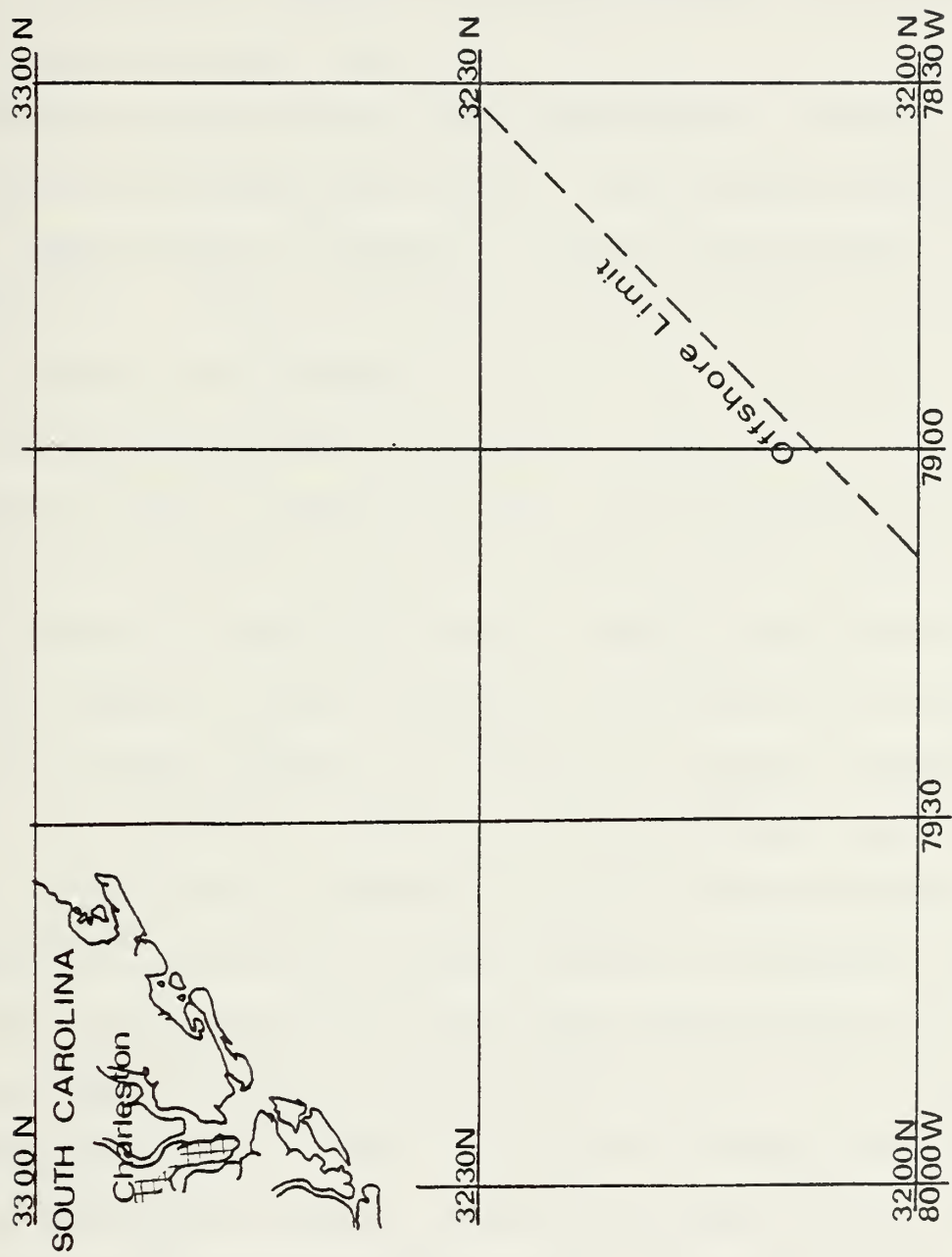


Figure 2
Index Map of Study Area

Nansen cast stations dating from 1966 to 1975 were included within this area.

Finally, the area also corresponded to NODC data format and limitations of existing computer programs for abstracting and manipulating this data.

The area extends from shore approximately fifty-five NM offshore (to the 200 meter curve). The majority of the region has a depth range of eighteen to seventy-three meters (10 to 40 fathoms). Bottom topography is gently sloping until the shelf break is encountered.

Surface circulation is seasonal in character and is influenced by the following factors: river run-off, horizontal temperature gradients, wind and coriolis force effects on tidal motions in restricted waters (Bumpus and Lauzier, 1965).

The region is mainly inshore of the Gulf Stream although the Gulf Stream affects its circulation patterns (Gaskell, 1972). No systematic study of seawater movement has been made, though several generalizations have been based on limited data from drift bottles (Kuroda and Marland, 1973).

The surface circulation has been characterized as having a prevailing northerly drift during the winter and spring (Bumpus and Lauzier, 1965). The pattern becomes less well-defined during the summer. During the summer transitional period there is water movement both to the south and to the north. The northerly movement is apparent in the very near shore region and over the outer edge of the shelf. Between these two motions is a southerly flow (Bumpus and Lauzier, 1965).

During the autumn, most of the region is under the influence of a southerly drift, with the exception of the outer portion of the shelf, where the flow is toward the northeast (Bumpus and Lauzier, 1965). Current speeds are maximum during the winter and autumn and a minimum during the summer months (U.S. Naval Oceanographic Office, 1965).

Kuroda and Marland (1973) noted that the surface circulation in this region is strongly dependent on the prevailing winds.

Figure 3 is a diagram exhibiting the seasonal nature of the surface currents in the area extracted from the American Geographical Society's "Serial Atlas of the Marine Environment, Folio 7".

Systematic study regarding water mass distribution or temperature and salinity distribution is limited in this region (Kuroda and Marland, 1973). The Bureau of Commercial Fisheries R/V THEODORE N. GILL studied this region in 1953 (Kuroda and Marland, 1973). Kuroda and Marland (1973) in "Physical and Chemical Properties of the Coastal Waters of Georgia" summarized the GILL data. Figure 4 is a station plan for the GILL cruises.

This data shows that the isotherms trend northeast and southwest, paralleling the coastline and the approximate axis of the Gulf Stream. Monthly minimum temperatures were observed inshore and maximums generally seen in the offshore areas. Minimum surface temperatures (10° - 23° C) occurred in January and February and maximum temperatures (27° - 29° C) occurred in June and July (Kuroda and Marland, 1973). Minimum and maximum

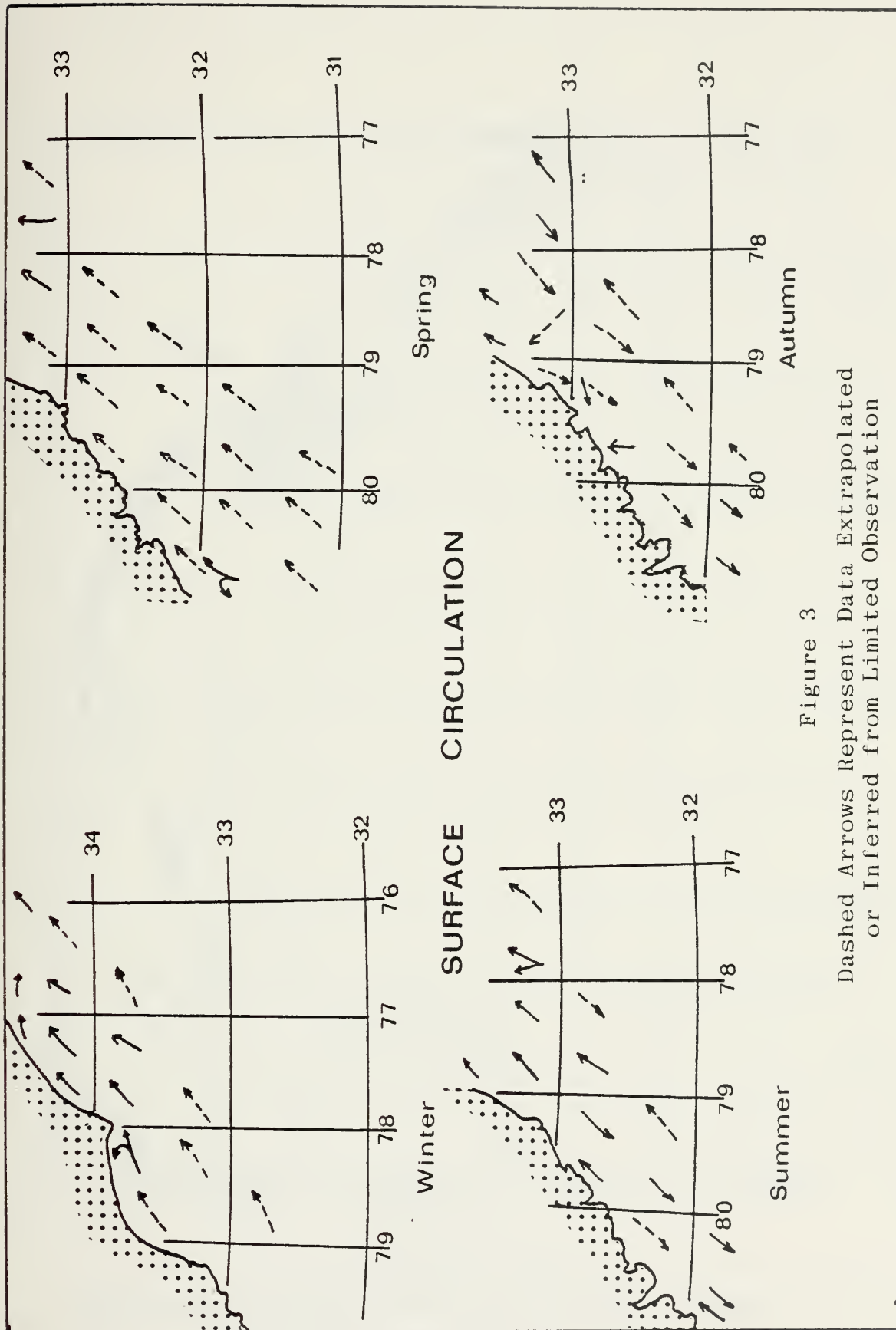


Figure 3
Dashed Arrows Represent Data Extrapolated
or Inferred from Limited Observation

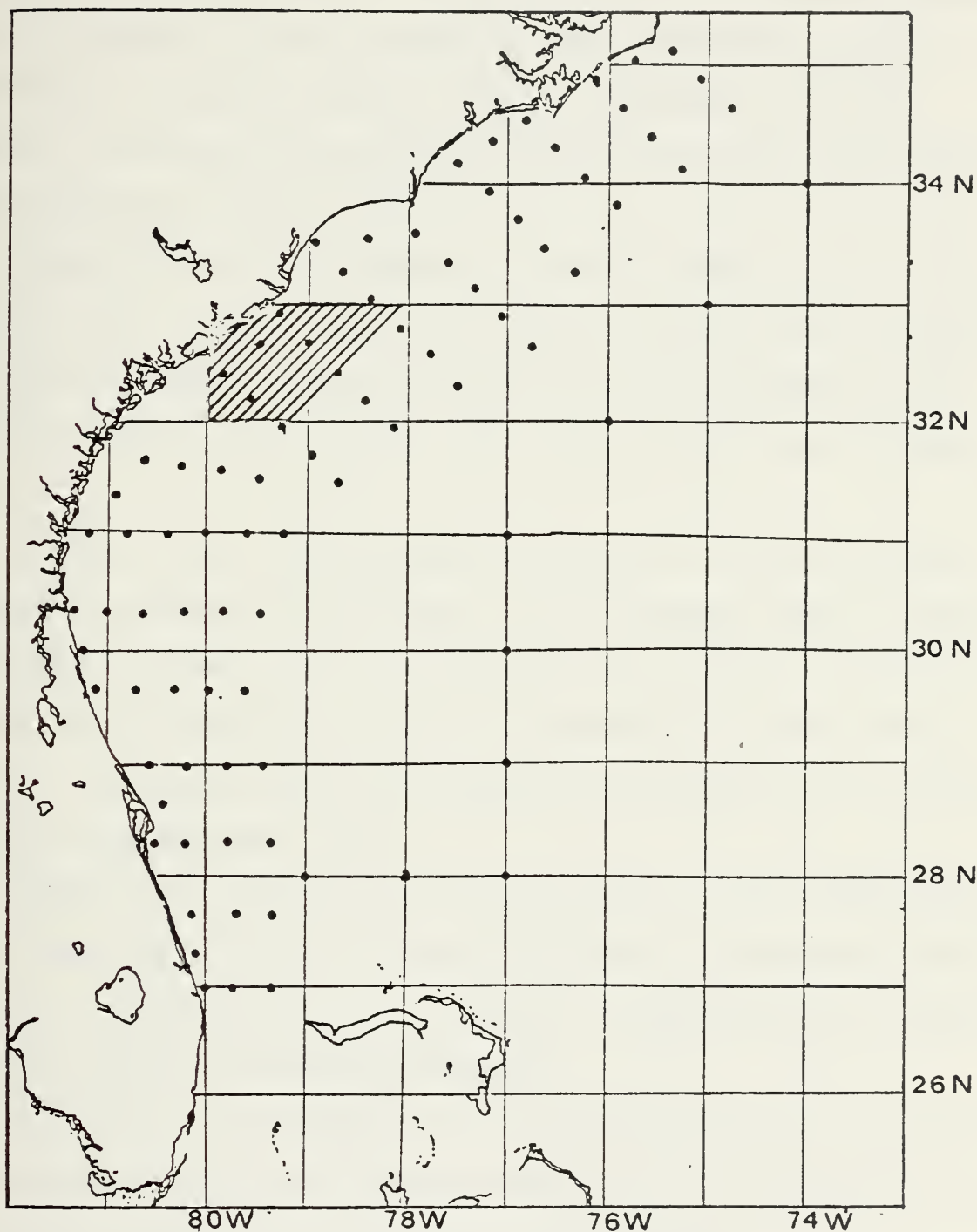


Figure 4

R/V GILL Station Plan
 Cross-hatched Region is Area of Present Study
 (From Kuroda and Marland, 1973)

temperatures at depth occurred gradually later with a direct depth relation (Kuroda and Marland, 1973). As an example, minimum temperature at 50 meters may occur in February whereas at 100 meters it occurs in March. The temperature at 200 meters at a point is nearly constant throughout the year. Table I, extracted from Kuroda and Marland (1973) summarizes the temperature distribution.

Isohalines are also shown to parallel the coastline (Kuroda and Marland, 1973). Near shore, surface salinities exhibited a seasonal change whereas offshore salinities showed little seasonal effect and remained near $36^{\circ}/\text{‰}$. (Kuroda and Marland, 1973).

Near the coast, the minimum salinities of $32^{\circ}/\text{‰}$ were observed in January and February, and the maximum value of $35^{\circ}/\text{‰}$ occurred in summer and autumn (Kuroda and Marland, 1973). Of particular interest are the near homogenous salinity values ($36^{\circ}/\text{‰}$) observed throughout the area at a depth of 50 meters (Kuroda and Marland, 1973).

Ranges for salinities at greater depths (100 to 200 meters) were also small ($35^{\circ}/\text{‰}$ to $36^{\circ}/\text{‰}$) (Kuroda and Marland, 1973). Table II, also extracted from Kuroda and Marland, is a summary of the salinity variations observed.

Analysis of the Temperature-Salinity diagrams for the R/V GILL data by Kuroda and Marland revealed the presence of four different types of water masses in the region.

The water mass present along the outer edge of the shelf is equivalent to the North Atlantic Central Water (NACW) as

TABLE I

TEMPERATURE (°C) IN THE WESTERN NORTH ATLANTIC

PERIOD \ DEPTH	0 METERS	10 METERS	50 METERS	100 METERS	200 METERS
JAN. - FEB.	10-23 (12)	11-24	18-24	14-24	12-21
FEB. - MARCH	12-24	12-24	16-24	12-24	9-20
APRIL - MAY	19-26	19-26	16-26	13-24	10-20
JUNE - JULY	25-29 (27)	24-28	18-27	15-25	11-20
JULY - AUG.	27-29	27-29	19-28	14-26	9-21
AUG. - SEPT.	25-29 (27-28)	25-29 (27-28)	20-28	11-26	9-20
NOV. - DEC.	13-26	13-26	21-26	17-26	9-20

TABLE II

SALINITY (‰) IN THE WESTERN NORTH ATLANTIC

PERIOD \ DEPTH	0 METERS	10 METERS	50 METERS	100 METERS	200 METERS
JAN. - FEB.	32-36	32-36	36-36.5	36	35-36
FEB. - MARCH	33-36	34-36	36-36.5	35-36	35-36
APRIL - MAY	34-36	34-36	36	35-36	35-36
JUNE - JULY	34-36	34-36	36	35-36	35-36
JULY - AUG.	34-36	35-36	36	35-36	35-36
AUG. - SEPT.	35-36	35-36	36	35-36	35-36
NOV. - DEC.	35-36	35-36	36	35-36	35-36

described by Stommel (1965) (Kuroda and Marland, 1973). This type exhibited the highest temperature and salinities observed. The water temperature above 100-200 meters showed large seasonal change but relative constancy below this depth (Kuroda and Marland, 1973).

A type of water labelled "mixing water" by Kuroda and Marland (1973), exhibited very similar properties to the NACW previously described but temperatures were approximately 5°C lower in winter and autumn. The salinities observed above 100 meters had almost identical values as the first type while at 200 meters there was a decrease of about .4‰. (Kuroda and Marland, 1973). The third water mass, described as shelf water, was nearer shore. Salinities between 34.5‰ and 36‰ were characteristic and exhibited much seasonal change (Kuroda and Marland, 1973).

A fourth water mass was identified as "coastal water" and occurred very near the shore. This water mass exhibited large seasonal changes of both temperature and salinity (Kuroda and Marland, 1973). Convenience in analysis of regional conditions was the primary purpose of Kuroda and Marland's classification. Figure 5 is a generalized map of the distribution of these water masses, extracted from Kuroda and Marland (1973).

The suite of water masses described extend out to approximately 100 miles offshore, just inside the western edge of the Gulf Stream. Each mass is continually interacting with the others resulting in modification to the original character.

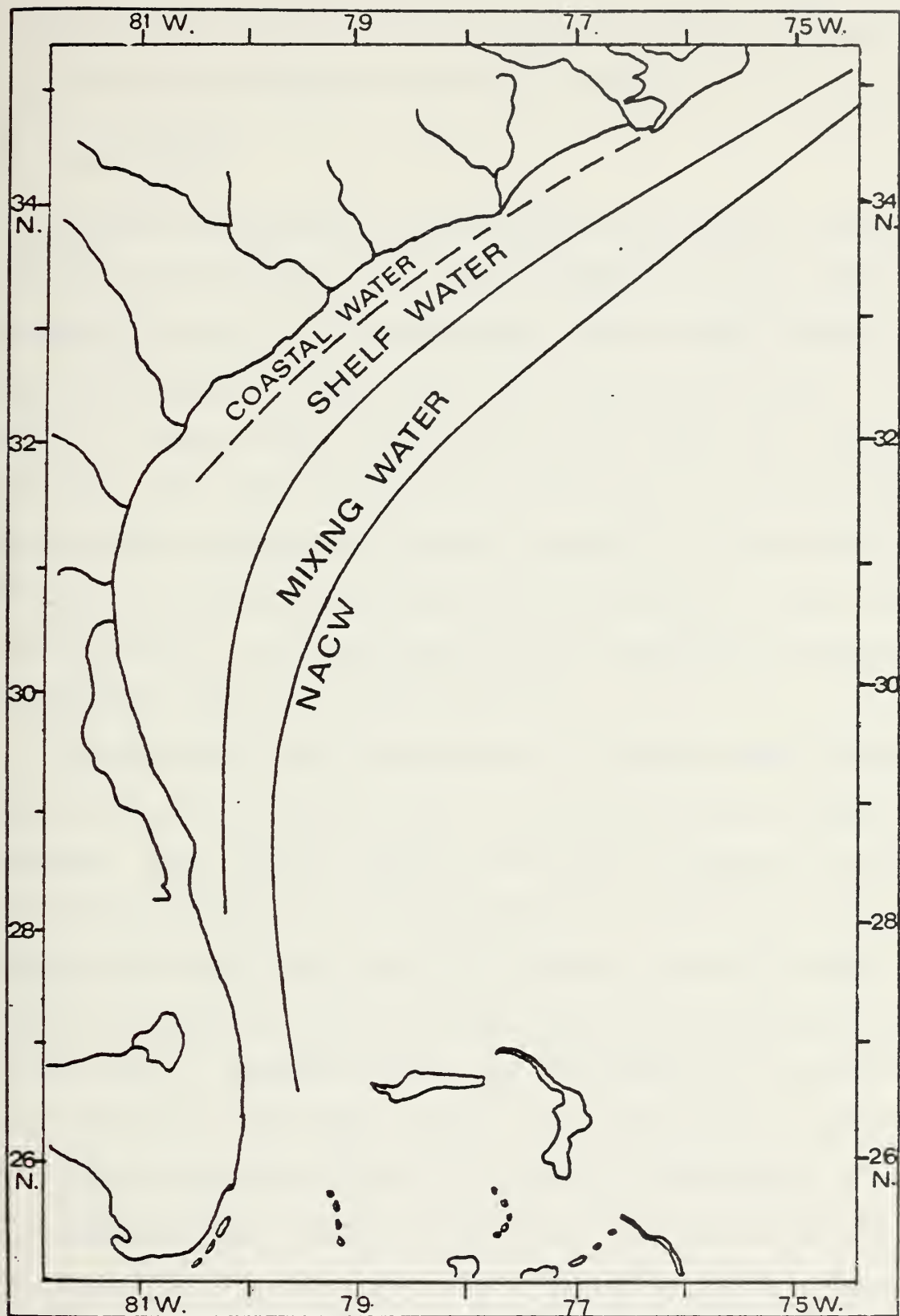


Figure 5
Water Mass Distribution

Seasonal distributions of these masses and their movement is also described by Kuroda and Marland (1973).

B. DATA SOURCE

The data utilized in this analysis was obtained from the National Oceanographic Data Center (NODC) in October 1978. A magnetic tape of all oceanographic station data (Nansen cast and STD stations) for Marsden square 116 was furnished. A total of approximately 300 stations were within the area of interest. The data consisted of temperature, salinity and sound speed (computed by Wilson's equation) for each station. Additional information included: position, date, time, ship identification and other meteorological chemical and optical information wherever it was measured.

The magnetic tape furnished was in standard NODC format: nine-track, 800 bits per inch, 80 character, full-blocked records. Each station record consisted of a master record containing positional and identification data and a detail record containing the salinities, temperatures and sound speeds obtained for each standard depth (to the maximum depth of the cast). Standard depths for oceanographic observations are a matter of agreement within the oceanographic community. NODC files contain records (for depths to 400 meters) at the following standard depths (in meters): 0, 10, 20, 30, 50, 75, 100, 125, 150, 200, 250, 300, 400 (NODC, 1974). Where observations do not conform to the standard depths, interpolations are made utilizing a 3-point Lagrange interpolation

equation (NODC, 1974). Wherever salinity, temperature and depth data are present and the values are not doubtful, sound speeds are computed (NODC, 1974).

C. TECHNIQUES FOR SUMMARIZING SOUND SPEED DATA

The objectives were to examine and summarize the historical sound speed data available and evaluate its suitability for determination of correctors for echo soundings in the study area.

Temperature and salinity variability was also examined and its relation to sound speed variability noted. Several methods for summarizing the sound speed variability in an oceanic region have been devised by other researchers.

Russell (1975) developed a method for selecting typical sound speed profiles from oceanographic station data with application to interpretations of acoustic system performance. The data was abstracted in groups representing estimates of natural temporal and spatial populations. The study utilized NODC data as well as available XBT data. In this method, the ocean regions represented natural oceanographic domains. Each domain exhibited similar physical properties and current regimes.

Russell's (1975) study is limited in application. The primary reason for this is difficulty in accessing data bases other than those maintained by NODC. The study is further limited because it is directed to deep water horizontal propagation.

The profiles generated are useful as pilot information but the variability of these profiles within a region is not defined with the precision required for application to the echo sounding problem.

Audet and Vega (1974) developed a similar technique to that of Russell (1975). The data utilized was exclusively the NODC Oceanographic Station File.

In this technique, all profiles for a region are examined. Three profiles which exhibit the smallest variations relative to all other profiles are selected, the profile exhibiting the least variability being selected as the model profile. The other two profiles are compared to the model and the standard deviation computed between the model and these two representative profiles. This study is of interest due to the methods employed. However, the study was primarily concerned with deeper oceanic regions and application to variable continental shelf areas is inappropriate.

The HIDAT program in use by the U.S. Naval Fleet Numerical Weather Central is used to characterize sound speed conditions in ocean regions for forecasting performance of military acoustic systems.

Output for the HIDAT program is a month-by-month summary showing the temperature and salinity profile which is found to be representative of a region. The representative profile is an actual observed profile which shows the smallest standard deviation from all other profiles in the region.

Standard deviations at standard depths are computed and represent variance of the representative profile from the four most similar profiles in the area.

The smallest region for which HIDAT information can be generated is a one-degree latitude-longitude square.

The data base for HIDAT includes all NODC data as well as extensive XBT data from other sources. This results in much greater data density for an area. The HIDAT program is similar to the system suggested by Audet and Vega (1974).

All three prior techniques were developed in response to specific operational requirements. None of the three was designed appropriately for echo sounding correction. Each technique was concerned with selection of an actual profile as the representative profile in a region. This is an important design criteria in that it permits identification of the sonic layer depth. Identification of the sonic layer depth is important for horizontal acoustic propagation. This was the application for each of the three studies examined.

The selection of an actual observed profile is unnecessary for vertical echo sounding because minor changes in location of the sonic layer depth have little effect on mean vertical sound speeds. Further research and adaptation of these programs to the echo sounding problem might result in useful techniques.

D. COMPUTER PROCESSING

All computer processing in this analysis was accomplished utilizing the IBM 360/67 computer system of the W. R. Church Computer Center at the U.S. Naval Postgraduate School (NPS).

In addition to the programs written to perform the required analysis of NODC data, several existing programs for abstracting and plotting NODC data were employed. These programs were written by Dr. R. G. Paquette of the Department of Oceanography, Naval Postgraduate School. All programs were written in Fortran and complete listings and documentation are contained in Appendix 1.

Initially, all station records from the NODC unlabelled magnetic tape were transferred to a standard NPS labelled tape. This resulted in a faster retrieval time and fewer errors in reading the tapes. Although the NODC tapes were compatible with tape drives at the NPS computer center, reading problems may occur whenever magnetic tapes are read on a drive different from the machine on which they are created. Transfer to the NPS standard labelled tape eliminated the errors associated with this problem.

A computer listing of all NODC station header records for Marsden Square 116 was made. This listing was produced using program NODCDUM, written by Dr. R. G. Paquette of the Naval Postgraduate School. These records were examined to locate all stations within the study area. The stations of interest were all located within two adjacent blocks of record numbers. This resulted from the format of NODC data

tapes. Within a Marsden Square, further blocking or subdivision of records is made by one-degree latitude and longitude squares.

A complete listing of the header and detail record for each station within the study area was then produced on a month-by-month basis. As an example, all stations observed in a particular month (all years) were listed together for ease in indexing. The program used to make this listing was NODCRD, also written by Dr. Paquette. The record produced was a hard copy printout of all stations observed each month. The information in this listing consisted of both the header record (position, date, year, country and ship identification and NODC index numbers) and the detail record giving the type of observation (Nansen or STD), temperature, salinity, density (σ_t), oxygen content and sound speed at each standard depth to the limit of observation. This listing served a reference and index function throughout the study. A sample record for one station is shown in figure 6.

Four punched data cards were produced for each station. The first card was produced using NODPUNA. It contained latitude, longitude, NODC reference number, month in which the observation was made, and the sound speeds for each depth to the limit of observation or 400 meters, whichever was shallower. Speeds were recorded to tenths of meters per second. The second card contained the same positional and index information but observed temperatures were abstracted to two decimal places instead of sound speeds. This card was

CTY	SHIP	LAT(N)	LONGITUD	MSQ	YR	MO	DY	HR	CRNO	STANO	DPHT	SDTH	NOBS	ID	TYP	N	NN	NREC	
31	PE	32-039	079-040	116	66	03	22	140	018	003		3		07820004	1	14	65	88620	
DEPTH	TEMPERATURE	SALINITY	SIGMA-T	OXYGEN	SV	TYPE													
0000	22.95	36.26	24.92	4.94	1531.3	6													
0000	22.95	36.260	24.92	4.94	1531.3	6													
0010	22.92	36.267	24.93	4.99	1531.4	3													
0010	22.92	36.267	24.93	4.99	1531.4	3													
0020	22.26	36.262	25.12	5.10	1529.9	3													
0030	21.55	36.274	25.33	5.20	1528.2	3													
0030	21.55	36.274	25.33	5.20	1528.2	3													
0040	20.68	36.246	25.55	5.34	1526.1	3													
0050	20.43	36.257	25.62	5.21	1525.6	3													
0050	20.43	36.257	25.62	5.21	1525.6	3													
0060	20.06	36.254	25.72	5.08	1524.7	3													
0075	19.84	36.247	25.95	4.79	1524.7	6													
0080	19.66	36.242	26.01	4.00	1524.3	3													
0100	18.36	36.280	26.18	4.59	1520.7	3													
0100	18.36	36.280	26.18	4.59	1520.7	3													
0125	18.09	36.258	26.23	4.69	1520.2	3													
0125	18.09	36.258	26.23	4.69	1520.2	3													
0140	17.87	36.247	26.28	4.70	1519.9	3													
0150	17.85	36.222	26.26	4.58	1520.0	3													
0160	16.94	36.198	26.46	4.35	1517.4	3													
0180	12.48	35.608	26.99	3.53	1502.8	3													
0190	03.43	35.166	27.20	3.02	1491.3	3													
0200	09.37	35.16	27.20	3.02	1491.3	3													
0210	08.56	35.048	27.24	3.01	1488.7	3													
0230	08.59	35.046	27.24	2.99	1489.1	3													
0250	08.59	35.05	27.24	2.97	1489.3	3													
0250	08.59	35.05	27.24	2.96	1489.5	3													
0270	08.56	35.055	27.25	2.99	1489.7	3													
0290	08.27	35.020	27.27	3.05	1488.9	3													
0300	08.26	35.02	27.27	3.05	1488.9	3													
0310	08.19	35.009	27.27	2.99	1488.9	3													

Figure 6

Sample NODCRD Output

For one Oceanographic Station

Type 3 indicates interpolated data

Type 6 indicates observed data

produced using NODPUNC. The third data card was also similar but salinities to two decimal places were abstracted for each standard depth. NODPUNB was used to produce these cards. The fourth data card was produced as input to a station plotting program, CHARTPLT. This card contained latitude and longitude of the station. The card was produced using NODPUN. This additional card with positional information was produced in order to avoid programming changes to accomodate a new format. Samples of all four cards are shown in figure 7.

The programs used to produce the first 3 cards (NODPUNA, NODPUNB, and NODPUNC) differed only in the record abstracted (speed, temperature or salinity). The temperature, salinity and sound velocity cards were used as input to the statistical program written to summarize the data.

VELDAT was the basic statistical program written to summarize the sound speed data. Slight modifications to this program, particularly in input format, resulted in programs SALDAT and TEMDAT. All three have the same basic functions, and produce the same results. VELDAT was used to analyze sound speed data, SALDAT for salinity data and TEMDAT for temperatures.

Input to these programs were the appropriate data cards previously described and shown in figure 7.

VELDAT output consisted of the mean sound speed profile (at standard depths), the standard deviation at each standard depth, number of samples included in the calculation and the

32200 78580	4	94	5277	5263	5248	5232	5201	5160	5117	0	0	0	0	0
LAT. LON. MO. ID. LAST 4 DIGITS OF SOUND SPEED AT STANDARD DEPTHS														
Card 1 (Input for VELDAT)														
32200 78580	4	94	2153	2093	2032	1972	1852	1701	1550	0	0	0	0	0
LAT. LON. MO. ID. TEMPERATURES AT STANDARD DEPTHS														
Card 2 (Input for TEMDAT)														
32200 78580	4	94	3629	3625	3621	3617	3609	3599	3588	0	0	0	0	0
LAT. LON. MO. ID. SALINITY VALUES AT STANDARD DEPTHS														
Card 3 (Input for SALDAT)														
31	16	3212	07933	54	07	03	89366							
Country Ship LAT. LON. These fields unused for this analysis														
Card 4 (Input for CHARTPLT)														
0000000000	0000000000	0000000000	0000000000	0000000000	0000000000	0000000000	0000000000	0000000000	0000000000	0000000000	0000000000	0000000000	0000000000	0000000000
1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111
2222222222	2222222222	2222222222	2222222222	2222222222	2222222222	2222222222	2222222222	2222222222	2222222222	2222222222	2222222222	2222222222	2222222222	2222222222
3333333333	3333333333	3333333333	3333333333	3333333333	3333333333	3333333333	3333333333	3333333333	3333333333	3333333333	3333333333	3333333333	3333333333	3333333333
4444444444	4444444444	4444444444	4444444444	4444444444	4444444444	4444444444	4444444444	4444444444	4444444444	4444444444	4444444444	4444444444	4444444444	4444444444
5555555555	5555555555	5555555555	5555555555	5555555555	5555555555	5555555555	5555555555	5555555555	5555555555	5555555555	5555555555	5555555555	5555555555	5555555555
6666666666	6666666666	6666666666	6666666666	6666666666	6666666666	6666666666	6666666666	6666666666	6666666666	6666666666	6666666666	6666666666	6666666666	6666666666
7777777777	7777777777	7777777777	7777777777	7777777777	7777777777	7777777777	7777777777	7777777777	7777777777	7777777777	7777777777	7777777777	7777777777	7777777777
8888888888	8888888888	8888888888	8888888888	8888888888	8888888888	8888888888	8888888888	8888888888	8888888888	8888888888	8888888888	8888888888	8888888888	8888888888
9999999999	9999999999	9999999999	9999999999	9999999999	9999999999	9999999999	9999999999	9999999999	9999999999	9999999999	9999999999	9999999999	9999999999	9999999999
1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111	1111111111

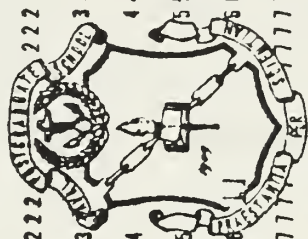


Figure 7

location and values of maximum and minimum sound speeds.

Temperature and salinity data were similarly analyzed.

The values for sound speeds at each standard depth for each station in the study area were input into VELDAT, grouped by season. As an example, all stations observed in January, February or March are examined together. Other seasons were defined as: Spring (April, May, June); Summer (July, August, September), and Autumn (October, November, December). This seasonal breakdown followed the practice of other researchers in the area (Kuroda and Marland, 1973).

Initially, sound speeds for each standard depth for all stations in the area were averaged and the sample mean computed. The following equation represents the computation made in VELDAT:

$$\overline{SV}_d = \frac{\sum_{i=1}^N SV_{d_i}}{N} \quad (5)$$

\overline{SV}_d was the mean sound speed at a particular standard depth (d) over the entire area. $\sum SV_{d_i}$ was the sum of all sound speed values at a particular standard depth, and N was the number of sound speed values found for a particular standard depth. Where no value was found for a particular depth or a zero value was encountered, this sample was not included and N was not incremented.

A sample standard deviation was computed for sound speeds at each standard depth utilizing the following equation:

$$S_{SVd} = \left[\frac{\sum (SV_{d_i} - \overline{SV}_d)^2}{N-1} \right]^{\frac{1}{2}} \quad (6)$$

S_{SVd} is the standard deviation of the sound speeds at a particular standard depth. \overline{SV}_d was the mean sound speed computed for the particular depth in question and N was the number of samples. The same procedure for dealing with blank or zero values was used in this computation as in the computation for mean sound speed. TEMDAT and SALDAT utilized the same equations for producing mean temperatures and salinities as well as standard deviations. Appendix 1 documentation includes input or data format required, variable specifications for different regions and modes of operation possible.

The procedure utilized to compute mean sound speeds and standard deviations at standard depths was suggested by the fact that present NOS practice dictates use of the "summation of layers" method for determination of sound speed corrections at depth. This method has been previously described in section I.C. of this thesis.

E. PROCEDURE

Sound speed data cards for all stations were produced and sorted by month. Variability of sound speeds over the entire area on a monthly basis was examined initially. Lack of substantial numbers of observations during any particular month precluded use of this technique for drawing meaningful conclusions.

Three month seasonal groupings were then combined and analyzed using VELDAT. The program output exhibited a larger variability than could be tolerated under the accuracy requirements stated. The question of applicability of historical data would have been quickly resolved had the variabilities over the entire area been small enough to match the stated accuracy requirements. However, this was not the case, the variability was too great; thus leading to a form of spatial subdivision.

The locations of stations exhibiting the maximum and minimum sound speed values revealed that grouping by area might reduce the observed standard deviations. These results, examined in view of the variation of physical properties of the waters (Kuroda and Marland, 1973), suggested a sub-division of the area into two regions. Since sound speed values should be similar for waters with similar physical properties, the objective of the sub-division was to separate the area into two natural populations of sound speed profiles. This method followed the procedure cited by Russell (1975), although his study was concerned with sub-division on a much larger scale.

The division was made along a northeast - southwest trending line approximately paralleling the 18 meter depth contour. The near-shore region resulting from this division was expected to exhibit much greater variations in sound speeds and hence a greater standard deviation. The offshore region was expected to show smaller variations of sound speed values. Figure 8 is a map of the area showing the division made. Sound speed

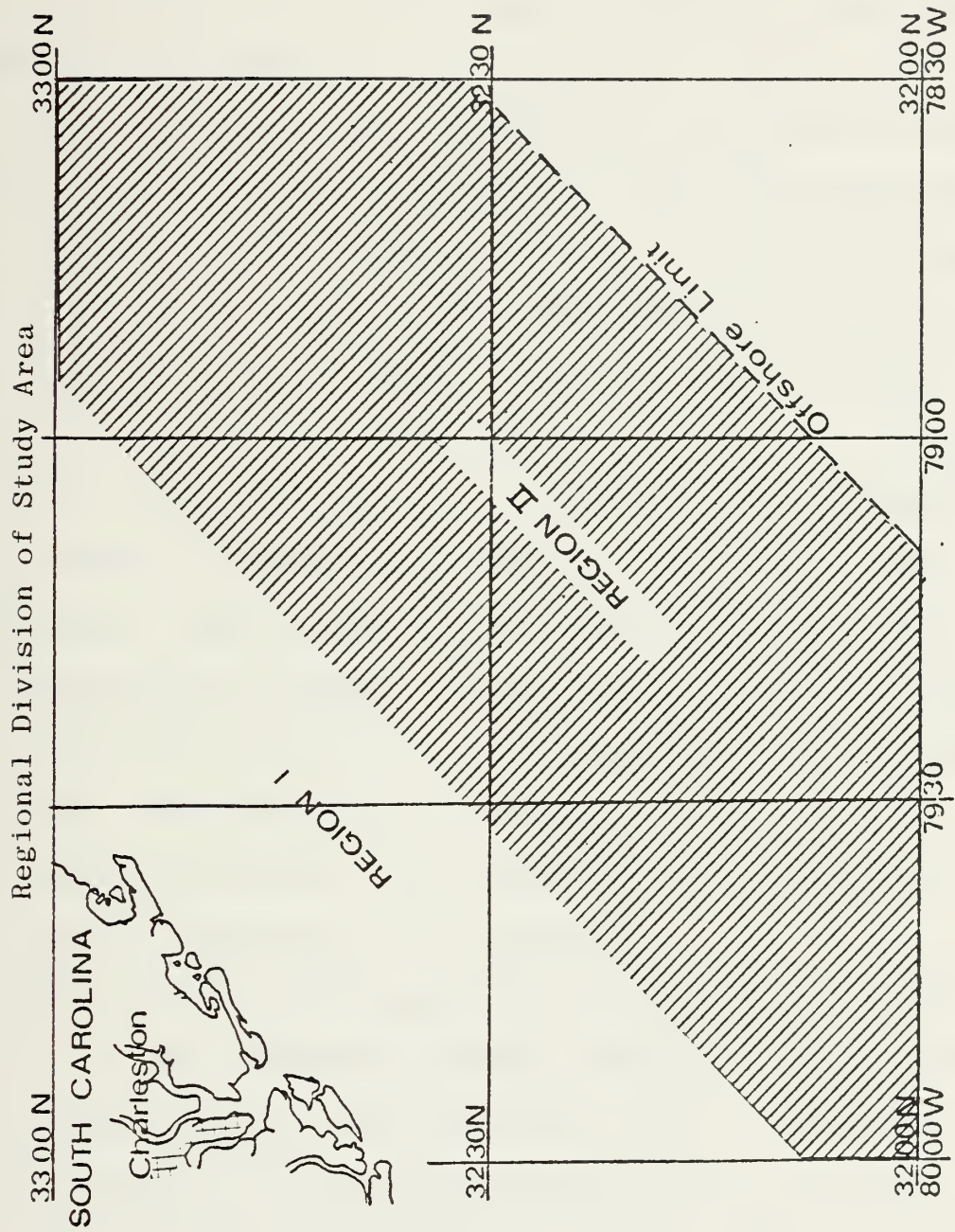


Figure 8

analysis was then achieved for each of the regions using VELDAT and the seasonal breakdown previously cited. A similar procedure was carried out in order to examine temperature and salinity variability in the region. TEMDAT and SALDAT were employed to this purpose.

Graphic profiles were produced from the VELDAT output showing the mean sound speed profile, and the maximum and minimum profiles for the offshore region. Profiles were produced for each season. Salinity and temperature profiles were also produced on a seasonal basis. Profiles for the inshore region were not produced due to the sparseness of data in the region.

Output from the statistical programs (VELDAT, TEMDAT, SALDAT) are included in Appendix 2. Seasonal Profiles of sound speed, temperature, and salinity are also included in Appendix 2.

Representative monthly temperature and salinity profiles were requested from HIDAT at Fleet Numerical Weather Central. The HIDAT output was used for comparison purposes with output from TEMDAT and SALDAT. The comparison was employed to validate results obtained in this analysis.

HIDAT salinity and temperature profiles were requested for the entire one-degree square, extending from latitude 32°N to latitude 33°N and from longitude 79°W to longitude 80°W. Typical values for salinity and temperature at standard depths for each month were the output for HIDAT. Data for the entire square was requested due to the fact that a one-degree square is the smallest subdivision possible with the HIDAT system. Seasonal averages of salinities and temperatures for standard

depths to 100 meters were made of the HIDAT typical profiles in order to compare the results with SALDAT and TEMPDAT output. The results of the comparison are summarized in Table III.

	WINTER					SPRING					SUMMER					FALL				
	TEM DAT Mean Temp. Deg-C	HIDAT Average Temp. Deg-C	SALDAT Mean Sal. (ppt)	HIDAT Average Sal. (ppt)	TEM DAT Mean Temp. (Deg-C)	HIDAT Average Temp. (Deg-C)	SALDAT Mean Sal. (ppt)	HIDAT Average Sal. (ppt)	TEM DAT Mean Temp. (Deg-C)	HIDAT Average Temp. (Deg-C)	SALDAT Mean Sal. (ppt)	HIDAT Average Temp. (Deg-C)	SALDAT Mean Sal. (ppt)	HIDAT Average Temp. (Deg-C)	TEM DAT Mean Temp. (Deg-C)	SALDAT Mean Sal. (ppt)	HIDAT Average Temp. (Deg-C)	SALDAT Mean Sal. (ppt)	HIDAT Average Temp. (Deg-C)	TEM DAT Mean Temp. (Deg-C)
Depth (M)																				
0	19.24	20.65	36.29	36.31	20.63	22.22	35.72	36.21	27.74	27.44	35.60	35.11		24.09	25.13	36.25		36.21		
10	19.05	20.65	36.28	36.30	20.49	22.20	35.86	36.24	27.32	27.21	35.68	35.59		24.03	25.11	36.25		36.24		
20	19.14	20.60	36.24	36.30	20.15	21.76	36.14	36.24	26.16	26.82	35.92	35.98		23.90	25.01	36.26		36.24		
30	19.35	20.45	36.28	36.30	19.90	20.16	36.22	36.24	24.23	23.11	36.12	36.32		24.32	24.78	36.26		36.25		
50	19.01	19.50	36.29	36.26	18.90	19.67	36.29	36.35	22.31	21.44	36.18	36.24		24.73	24.46	36.34		36.25		
75	18.26	****	36.27	****	17.81	****	36.28	****	19.69	****	36.09	****		23.29	****	36.35		****		
80	****	18.14	****	36.19	****	18.87	****	36.35	****	18.85	****	36.21		****	23.19	****		36.19		
100	17.46	16.72	36.24	36.08	16.25	17.48	36.19	36.30	16.94	17.43	35.87	36.29		21.17	19.48	36.36		36.18		

TABLE III

Comparison of HIDAT Results with TEMDAT
and SALDAT Results

III. RESULTS

VELDAT analysis of the inshore region (I) of the study area produced little in the way of usable results. Data density in this region was so sparse as to render the results statistically meaningless. Less than 50 stations (all months, all years) were observed in region I.

Results of the analysis of region I exhibited standard deviations in the range of 1.2 meters/sec to 8.6 meters per second, depending on the season. Information was confined to the upper 10 meters of the water column as there were no observations below this depth. Computations were based on a maximum of 16 samples for any one season. Table IV is a summary of VELDAT results for this region.

The results indicated for region I clearly show that lack of adequate samples of historical data in the form of archived STD and Nansen Cast observations precludes use of this method to obtain velocity correctors for echo sounding.

In-situ observations would have to be made of temperature, salinity and depth in this region in order to obtain velocity corrections. This result is important in itself since it identifies a region lacking in data.

Results of the analysis for region II are exhibited in appendix 2. A plot of all stations observed is included as appendix 3. Stations are plotted on a seasonal basis. The results produced indicated that there was little information with which to work for depths greater than 100 meters.

TABLE IV
SUMMARY OF VELDAT RESULTS
REGION I

SEASON	DEPTH	MEAN SOUND SPEED	MAXIMUM SOUND SPEED	MINIMUM SOUND SPEED	STANDARD DEVIATION	NUMBER OF SAMPLES
W I N T E R	0 (SURFACE)	1503.3	1518.4	1498.0	7.5	6
	10	1504.6	1518.6	1500.3	7.0	6
S P R I N G	0	1520.6	1527.4	1513.8	4.1	12
	10	1519.4	1522.8	1513.1	2.8	8
S U M M E R	0	1540.5	1543.3	1538.0	1.4	16
	10	1540.7	1543.0	1538.0	1.5	12
A U T U M N	0	1523.4	1532.2	1509.5	8.3	11
	10	1522.7	1532.3	1509.8	8.6	9
	(METERS)	(M/SEC)	(M/SEC)	(M/SEC)	(M/SEC)	

However, the major portion of region II exhibits depths in the range of 18 to 95 meters (exceptions along the shelf break noted).

Winter mean sound speeds computed ranged from 1521.5 m/s at the surface to 1517.9 m/s at a depth of 100 meters. Standard deviations of sound speeds ranged from 4.4 m/s (at 75 meters) to 5.7 m/s (at 100 meters).

Mean temperatures for the same period ranged from 19.24°C at the surface to 17.46°C at 100 meters. Standard deviations ranged from 1.89°C at the surface to a minimum of 1.53°C at 50 meters.

Mean salinities exhibited a spread that ranged from 36.29‰ at the surface to 36.24‰ at 100 meters with standard deviations showing a maximum spread of from .10‰ (surface) to .32‰ (20 meters).

Results for the spring showed less variability. Mean sound speeds for the spring ranged from 1524 m/s at the surface to 1514.4 m/s at 100 meters. Standard deviations were in the range of 4.2 m/s at the surface to 2.6 m/s at 75 meters.

Mean temperatures for this season ranged from 20.63°C at the surface to 16.25°C at 100 meters. Standard deviations were in the range of 1.75°C at 10 meters to .87°C at 75 meters.

Mean salinities ranged from 35.72‰ at the surface to 36.19‰ at 100 meters. Standard deviations of .77‰ (surface) to .15‰ (50 meters) were observed.

The summer months exhibited the smallest variation in sound speeds only in the upper 10 meters.

Summer mean sound speeds ranged from 1541.7 m/s at the surface to 1515.6 m/s at 100 meters. Standard deviations ranged from 1.7 m/s (surface) to 11.1 m/s (100 meters).

Mean temperatures ranged from 27.74°C at the surface to 16.94°C at 100 meters. Variability as exhibited by standard deviations ranged from .78°C (surface) to 3.58°C (100 meters).

Mean salinities ranged from 35.60‰ at the surface to a maximum of 36.18‰ (50 meters). Standard deviations ranging from .53‰ (surface) to .21‰ (50 meters) were noted.

Autumn mean sound speeds ranged from 1533.9 m/s at the surface to 1527.8 m/s at 100 meters. Standard deviations ranging from 3.3 m/s (30 meters) to 13.8 m/s (100 meters) were computed.

Mean temperatures for any particular depth during this period ranged between 24.73°C (50 meters) and 21.17°C (100 meters). Standard deviations were in the range of 1.2°C (50 meters) to 4.91°C (100 meters).

Mean salinities ranged from 36.25‰ at the surface to 36.36‰ at 100 meters. Standard deviations for any depth fell in the range of .10‰ (20 meters) to .34‰ (100 meters).

The results indicate that sound speeds are least variable during the spring. This corresponds to the period of when temperatures throughout the column are least variable.

Near surface summer temperatures (1-10 meters) showed the least variation for any particular period or depth but variation increased substantially below 10 meters depth.

Salinities were least variable during the winter and fall, but standard deviations of salinity were always less than 1‰. If a two sigma variation were examined, only two computed salinity standard deviations would be in excess of 1‰ (surface and 10 meter depth during the spring).

Examination of the physical properties and seasonal nature of waters in this region based on the R/V GILL data as presented by Kuroda and Marland (1973) shows that these results are as expected.

Table V is a summary of the Region II standard deviations of sound speed, temperature and salinity on a seasonal basis abstracted from the results exhibited in appendix 2.

The relation between temperature and sound speed is already well-documented. Sound speeds calculated with Wilson's (1960) equation are more dependent on temperature than on salinity and pressure effects combined. Therefore it is reasonable to expect the largest variation of sound speed to occur when temperature variation is a maximum. A 1°C temperature increase will produce a corresponding increase in sound speed of 4.5 m/s. Likewise, a 1‰ salinity increase produces 1.3 m/s increase in sound speed and 100 meters depth increase will produce a 1.4 m/sec sound speed increase (Ingham, 1975).

The results obtained, indicate that sound speed variability is much more sensitive to temperature variation than to salinity variation. In addition, the results indicate that the greatest variation in sound speeds does not occur at the surface but at some depth below it, corresponding to the depth of greatest



TABLE V
VARIABILITY (ONE-SIGMA) OF SOUND SPEED, TEMPERATURE, AND SALINITY

DEPTH (m)	WINTER			SPRING			SUMMER			AUTUMN		
	SOUND SPEED (M/SEC)	TEMP. (°C)	SALINITY (ppt)	SOUND SPEED (M/SEC)	TEMP. (°C)	SALINITY (ppt)	SOUND SPEED (M/SEC)	TEMP. (°C)	SALINITY (ppt)	SOUND SPEED (M/SEC)	TEMP. (°C)	SALINITY (ppt)
0	5.4	1.85	0.10	4.2	1.72	0.77	1.7	0.78	0.53	4.5	1.81	0.17
10	5.3	1.84	0.10	4.1	1.75	0.61	1.8	0.84	0.48	4.4	1.78	0.13
20	4.9	1.70	0.32	3.6	1.71	0.23	3.3	1.39	0.32	4.5	1.84	0.10
30	4.9	1.69	0.12	4.1	1.56	0.21	5.4	2.19	0.21	3.3	1.35	0.12
50	4.5	1.53	0.14	2.8	1.03	0.15	6.0	2.31	0.21	3.0	1.20	0.18
75	4.4	1.69	0.14	2.6	0.87	0.18	7.0	2.45	0.38	7.5	2.84	0.21
100	5.7	1.81	0.20	3.2	0.97	0.29	11.1	3.58	0.50	13.8	4.91	0.34

temperature change. The depth of greatest temperature change varies between 75 and 100 meters depending on the season. This boundary layer between the zone responding to climatic and mixing effect and a lower zone of constant temperature decrease is usually noted as the thermocline depth. However the thermocline in this region is not well-defined. The motion of this boundary layer in the vertical leads to the large variability of temperatures observed at depths between 75 and 100 meters.

The comparison of results achieved during this study with the averaged HIDAT results revealed that, in general, HIDAT temperature averages were 1°C to 2°C higher than TEMDAT mean temperatures. HIDAT salinities agree with SALDAT mean salinities to within .5‰ for almost all cases.

The temperature variation noted is probably due to two factors:

- 1) The HIDAT routine used considerably more data in the form of XBT observations than the data base for TEMDAT contained.
- 2) The HIDAT data is more heavily weighted toward deeper (farther offshore) portions of the area. This is also the region of higher temperatures since isotherms parallel the coast and temperatures increase offshore. The "weighting" is due to the fact that XBT observations are not made in the shallow (200 meters near shore coastal regions as often as they are at depths greater than 200 meters).

The significance of the HIDAT comparison lies in the fact that it was an independent selection scheme used to check results obtained in this study.

IV. CONCLUSIONS

The results of the VELDAT analysis for region I were less than satisfactory. Low data density in this region precludes the determination of sound speed profiles with any statistical certainty. Therefore, the use of historical sound speed information for correction of echo soundings is precluded in this region.

In-situ measurement of temperature, salinity and depth or sound speed directly would have to be made in this region in order to correct echo soundings. Extrapolation of this result to other near shore regions on the east coast of the U.S. was not done. Nevertheless, a cursory examination of the number of stations occurring in the near shore region of Marsden Square 116, of which the study area is a portion, indicates that low data density in these regions will be a limiting factor.

Results of the analysis for the offshore region (II) allow several conclusions to be drawn.

NOS accuracy considerations require that mean sound speed be known to within ± 4 m/sec. Considering the variability involved in making measurements of parameters from which sound speed is computed, it is the author's opinion that this requirement can logically be interpreted to include 95.5% of the observations or a variability of two standard deviations (2σ).

Table 5 shows the value in meters per second of a one-sigma variation at each standard depth computed using VELDAT for each season. This table also gives the value of a one sigma variation for salinity and temperature at each standard depth.

The results summarized in table 5 indicate that two standard deviations at any standard depth would exceed the required ± 4 meter per second value for sound speed, with the exception of the upper 10 meters during the summer.

Further, during the winter, all values for one standard deviation exceed the ± 4 m/sec requirement at all standard depths.

Other seasons show values of one-standard deviation which exceed the ± 4 meter per second requirement for some portions of the water column.

The variability of the historical data exceeds the ± 4 m/sec. criteria at the 2σ level, hence the question of whether or not historical information is adequate to develop echo sounding corrections is answered as negative for this region.

Data generated as a result of this study indicated that changes in present methods for in-situ determination of sound speeds would be possible.

The salinity data presented indicates that this is the least variable parameter affecting sound speed. Salinity data shows that the greatest standard deviation observed was $.77^\circ/\text{‰}$, and this was atypical. Standard deviations for the most part were in the range of $.1^\circ/\text{‰}$ to $.5^\circ/\text{‰}$.

The analysis of Wilson's (1960) equation (Bivins, 1976) indicates that a natural variability of $3^\circ/\text{‰}$ in salinity could be tolerated if temperature measurements were made with sufficient accuracy ($\pm 0.1^\circ\text{C}$).

If one sigma variation is in the range of $0.1^\circ/\text{‰}$ to $0.8^\circ/\text{‰}$, it is clear that if this were extrapolated to 2σ to include 95.5% of the values, the variability would not exceed $3^\circ/\text{‰}$. Therefore temperature observations alone, and historically determined salinities would appear to meet the stated accuracy requirements. Such temperature observations could be made with the XBT system, instead of the currently used Nansen bottles with reversing thermometers and STD probes with increased efficiency.

XBT's are presently available with resolution capabilities of 0.01°C in temperature and 0.9 meters in depth (McDowell, 1978). This increased resolution over previous devices results from improved recorder design (McDowell, 1978).

Accuracy limits of the XBT have been quoted as "less than 0.2°C error 95% of the time" (Naval Oceanographic Office, 1978). Accuracy of the depth measurements obtained by the XBT are stated as less than 5 meters (Naval Oceanographic Office, 1978).

It has been suggested that accuracy improvements in XBT measurements can be obtained by utilizing an improved "rate of fall equation" for the probe (McDowell, 1978). Improved factory selection of thermistors used in XBTs including calibration could also increase repeatability of the measurements. Further testing and definition of the accuracy that can be obtained utilizing the XBT would be desirable.

Finally, the data base used in this study indicated that near-shore data for the study area was sparse. This fact may be characteristic of NODC files for near-shore coastal regions. Further efforts to improve the NODC data base would result in an improved determination of variability in the region.

Investigation of the T-S relation in these regions may also prove useful for corrector determination. Where the T-S relation proves sufficiently constant, salinity determination may be made on the basis of water temperature alone. Further study will be necessary to define this relationship and determine applicable regions.

The results obtained during this analysis, while not statistically rigorous, present a general picture of sound speed variability within a shelf region and answer the question of applicability of historical information to the correction of echo soundings.

APPENDIX 1: Computer Programs

***** NODCDUM *****

SOURCE: DR. R.G. PACQUETTE

THIS PROGRAM PROVIDES A LISTING OF HEADERS FOR NPS688 AND
ASSIGNS A SERIAL NUMBER IN COLUMNS 81-85

```

DIMENSION HDR1(9),HDR4(9)
REWIND 4
NREC=0
NHD=0
WRITE(5,10)
10 FORMAT(1X,' LISTING OF HEADERS FOR NODC TAPE: NPS433',44X,'NHD',3X,
1,NREC)
11 READ(4,100,END=300)HDR1,HDR2,HDR3,HDR4,HDR5,ITYP
100 FORMAT(9A4,A1,A4,9A4,A2,I1)
NREC=NREC+1
IF(ITYP.NE.1)GO TO 11
NHD=NHD+1
WRITE(6,200)HDR1,HDR2,HDR3,HDR4,HDR5,ITYP,NHD,NREC
200 FORMAT(1X,9A4,A1,A4,9A4,A2,I1,2X,I5,2X,I6)
GO TO 11
300 WRITE(5,400)
400 FORMAT(//5X,'END OF FILE')
999 STOP
END
//GO.FT04F001 DD UNIT=3400-4,VOL=SER=NPS688,DISP=(OLD,KEEP),
// DCB=(DEN=2,RECFM=FB,LRECL=80,BLKSIZE=3200),LABEL=(1,SL,IN),
// DSN=S2514.NDC2

```

CCCCCCCCCCCC

NODCPUNCH 15 NOVEMBER 1978

THIS IS THE SECOND IN A SERIES OF THREE PROGRAMS WHICH WILL READ
SELECTED STATIONS FROM NODC TAPES(NODCRD MOD 3), PUNCH DATA CARDS
(NODCPUNCH), AND PLOT CROSS SECTIONS OF TEMPERATURE, SALINITY,
AND SIGMA-T().

THIS PROGRAM READS SELECTED STATIONS FROM NODC TAPES, PRINTS THE
HEADER INFO, PUNCHES PARTIAL HEADER INFO(FOR STATION ID PURPOSES
ONLY), AND SELECTED STATION DATA. IF ORIGINAL STATION DATA IS
DESIRED SET NNUM=6, IF INTERPOLATED DATA IS DESIRED SET NNUM=3.

STATIONS ARE SELECTED AS IN NODCRD MOD 3:

A. BY DIRECT COMPARISON OF ONE FIELD(4 CHARACTERS MAX.) WITH
A TEST CONSTANT IN A-FORMAT.

B. SAME AS A. BUT WITH TWO FIELDS.

C. EITHER OR BOTH FIELDS IN A AND B MAY BE TESTED BY .GE.IX
OR .GE.IX.AND.LE.IY TYPE OF CRITERIA IN I-FORMAT.

CARD INPUT AND INSTRUCTIONS ARE CODED AS FOLLOWS.

CARD NO.1 : 80 BYTES OF FORMAT FOR READING CARD NO. 2. TYPICALLY
FOR ONE A-FORMAT COMPARISON FIELD, ONE BLANK, AND TWO INTEGERS:

(10A4,4X,11,4X,11,1X,A2,2X,A4,11,1X,14,14,16,5X)

CARD NO.2 : 40 BYTES OF VARIABLE FORMAT FOR READING THE TEST
VARIABLES IA AND IB FROM TAPE. ALWAYS SPECIFY TWO, EVEN THOUGH
YOU MAY ONLY USE THE FIRST. IN COLUMN 45 (MD3) PUT A ZERO OR BLANK
IF ONE TEST VARIABLE IS TO BE USED; ANY OTHER NUMERAL WILL
INDICATE TWO TEST FIELDS. IN COLUMN 50 (MD1) A ZERO OR BLANK INDICATES
PURE CHARACTER RECOGNITION, A .1. INDICATES .GE. A SINGLE CONSTANT,
A .2. INDICATES .GE. TEST CONSTANT NO. 1, TC1, AND .LE. TC2;
TC1 AND TC2 ARE ENTERED IN COLUMNS 52-55 AND (IF APPROPRIATE) 56-59.
IS CODED SIMILARLY IN COLUMNS 60-69. COLUMN 60 (MD2) IS LIKE 50. TC3
AND (IF APPROPRIATE) TC4 ARE ENTERED IN 62-65 AND 66-69 RESPECTIVELY.
COLUMNS 70-75 CONTAIN AN INTEGER SPECIFYING THE NUMBER OF RECORDS
TO BE SKIPPED BEFORE PROCESSING; IF BLANK, NO SKIPS.


```

CARD NO. 3: 40 BYTES FOR ENTERING A FORMAT FOR WRITING THE TEST
CONSTANTS,E.G.:

      (1X, TC1='A3,', TC2='A4,', TC3='I4, TC4='I4)

NOTE SOME MANIPULATIONS TO RECOVER THE MINUS SIGN IN TEMPERATURE
WHICH APPEARS AS AN 11 OR 12 PUNCH IN THE FOURTH DIGIT

DIMENSION FMT1(10),FMT2(20),FMT(20),HDR1(19)
INTEGER CC,YR,DAY,HR,STANO,DPTH,SDTH,TYP,T21,F1,D1,ZE,TC1,TC2,TC3,TC4
DATA SGN1//,SGN2//,F1/ZF0404040/,D1/ZD0404040/,
1ZE/Z50404040/,SV1//,DOT//,
CALL REREAD
REWIND 4
WRITE(6,6)
6 FORMAT(//)
N IS THE NUMBER OF HEADERS PRINTED,NN IS THE NUMBER OF HEADERS READ,
NPG IS THE COUNT OF NUMBER OF LINES PRINTED ON PAGE,NOPAGE IS THE
PAGE NUMBER,NREC IS THE NUMBER OF RECORDS READ
NOPAGE=0
N=0
NN=0
NPG=0
NRD=0
NNUM=6

      READ FORMATS,ETC
400 FORMAT(20A4)
401 WRITE(6,401)FMT
401 FORMAT(1X,FMT='20A4)
402 READ(5,FMT1)FMT1,MD3,MD1,TC1,TC2,MD2,TC3,TC4,ND
402 WRITE(6,402)FMT1,MD1,MD2,ND,MD3
402 FORMAT(1X,FORMAT FOR READING TEST VARIABLES FROM TAPE,MODE1,MODE2
1,THE NUMBER OF RECORDS TO BE SKIPPED,AND MODE3 ARE:,,/X,10A4,2I5,
1I10,15)
403 READ(5,403)FMT2
403 FORMAT(20A4)
403 WRITE(6,FMT2)TC1,TC2,TC3,TC4
      SKIP DIRECTLY TO PRINTING DATA, IF THERE IS NONE TO BE SKIPPED.
K=0
NREC=0
77 IF(ND.EQ.0)GO TO 99

```



```

C      READ THE UNWANTED DATA
C      K=1
C      8 READ(4,9,END=200,ERR=190)
C      9 FORMAT(79X,I1)
C      IF(K.GE.ND) GO TO 99
C      K=K+1
C      GO TO 8
C      END OF UNWANTED DATA LOOP
C
C      99 NREC=K
C
C      NCPAGE=NCPAGE+1
C      WRITE(6,50)
C      50 FORMAT(11)
C      WRITE(6,3) NCPAGE
C      3 FORMAT(9X,'SELECTED HEADERS FOR BERING AND/OR CHUKCHI AND/OR BEAUF
C      10RT SEAS',PAGE',I3//)
C      NPG=NPG+3
C      WRITE THE HEADING FOR THE HEADER RECORD DATA.
C      5 WRITE(6,4)
C      4 FORMAT(5X,'CTY SHP LAT(N) LONGITUDE YR MN DY STANO NRE
C      1C,/)
C
C      K=0
C
C      -----BEGIN MAIN LOOP-----
C
C      11 CONTINUE
C
C      HDR1 AND HDR2 CONTAIN ALL HEADER INFO EXCEPT TYPE WHICH IS THE
C      TEST VARIABLE TYP
C
C      NREC=NREC+1
C
C      THE NEXT CARD IS ONLY TO BE USED FOR NPS688 IN THE ATLANTIC
C
C      IF(NREC.GE.90865)GO TO 194
C      110 READ(4,110,END=200,ERR=190)HDR1,HDR2,TYP
C      FORMAT(19A4,A3,I1)
C      IF(TYP.NE.1)GO TO 11
C      NN=NN+1
C      READ(99,FMT1)IA,IB
C      CALL TEST(IANS,MD1,MD2,MD3,TC1,TC2,TC3,TC4,IA,IB)
C      A RETURN OF IANS=1 INDICATES TEST SATISFIED
C      IF(IANS.NE.1)GO TO 11
C      READ(99,10)CC,SH,LATD,LATM,LJND,LONM,LONM1,MSQ,YR,MO,DAY,STA
C      1NO

```



```

10 FORMAT(3A2,2A3,3A1,A3,3A2,6X,A3)
12 N=N+1
   NPG=NPG+2

C   WE EXAMINE LONM1 WHICH HAS AN OVERPUNCH FOR EAST LONGITUDES,
C   BECOMING D1,D2,ETC. AND DO INSTEAD OF F1,F2, AND F0.
C   WE START BY SUBTRACTING ZF0. IF THE RESULT IS .GT. ZERO, THE
C   DIGIT HAD NO OVERPUNCH AND WE RECREATE THE DIGIT. IF THE
C   RESULT IS .LT. ZERO, WE SUPPLY THE MINUS SIGN, FIND OUT IF IT WAS
C   A DIGIT .GT. ZERO BY A SIMILAR PROCEDURE, ETC.

NB=LONM1-F1
IF(NB.GE.0) GO TO 43
SIGN MUST BE NEGATIVE.
SGN=SGN2
RECREATE ORIGINAL DIGIT AND SUBTRACT ZD0: THIS ALSO CONVERTS
A Z50 INTO A 100C0000, A -0.
NB=NB+F1-D1
IF(NB.GE.0) GO TO 45
RECREATE DIGIT IF IT WAS NOT AMONG 0 TO 9 AND PRINT IT UNCHANGED.
NB=NB+D1
GO TO 47
43 SGN=SGN1
45 NB=NB+F1
47 WRITE(6,20)CC,SH,LATD,LATM,SGN,LOND,LONM,NB ,LONM2,YR,MO,DAY,STA
   INO,NREC
20 FORMAT(/6X,A2,2X,A2,1X,A2,A3,4X,A1,A3,3A1,3X,3(A2,1X),1X,A3,10X,I6
1)
WRITE(7,21)CC,SH,LATD,LATM,SGN,LOND,LONM,NB ,LONM2,YR,MO,DAY,STA
   INO,NREC
21 FORMAT(6X,A2,2X,A2,1X,A2,A3,4X,A1,A3,3A1,3X,3(A2,1X),1X,A3,10X,I6)
WRITE(6,24)
24 FORMAT(' ')
   NPG=VPG+2

C   27 NREC=NREC+1
C   READ DATA
   READ(4,30)END=200,ERR=192) D,T1,T2,T21, T22,S1,S2,ST1,ST2,
1SV2,SV3,O1,O2,TYP
30 FORMAT(T28,A4,1X,A2,3A1,A2,A3,A2,A2,T47,A3,A1,A1,A2,T80,I1)
   IF(TYP.NE.1)GO TO 31
   NN=NN+1
   IF(NPG.LE.70)GO TO 32
   NOPAGE=NOPAGE+1
   NPG=0
   WRITE(6,50)
   WRITE(6,3)NOPAGE
   WRITE(6,4)

```



```

32 READ(99,FMT1JIA,IB
CALL TEST(IANS,MD1,MD2,MD3,TC1,TC2,TC3,TC4,IA,IB)
IF(IANS.NE.1)GO TO 11
READ(99,10)CC,SH,LATD,LOND,LATM,LONM,LONM1,LONM2,MSQ,YR,MO,DAY,STA
IND TO 12
GO TO 12
C WE EXAMINE T21, WHICH HAS AN OVERPUNCH FOR A MINUS SIGN,
C BECOMING D1,D2,ETC. AND DO INSTEAD OF F1,F2, AND F0.
C WE START BY SUBTRACTING ZF0. IF THE RESULT IS .GT. ZERO, THE
C DIGIT HAD NO OVERPUNCH AND WE RECREATE THE DIGIT. IF THE
C RESULT IS .LT. ZERO, WE SUPPLY THE MINUS SIGN, FIND OUT IF IT WAS
C A DIGIT .GT. ZERO BY A SIMILAR PROCEDURE, ETC.
31 IF(TYP.NE.NNUM)GO TO 27
NB=T21-F1
IF(NB.GE.0) GO TO 33
SIGN MUST BE NEGATIVE.
SIGN=SGN2
RECREATE ORIGINAL DIGIT AND SUBTRACT ZD0; THIS ALSO CONVERTS
A Z50 INTO A 1000000, A -0.
NB=NB+F1-D1
IF(NB.GE.0) GO TO 35
RECREATE DIGIT IF IT WAS NOT AMONG 0 TO 9 AND PRINT IT UNCHANGED.
NB=NB+D1
GO TO 37
33 SGN=SGN1
35 NB=NB+F1
37 WRITE(6,95) D,SGN,T1,DOT,T2,NB,T22,S1,DOT,S2,ST1,DOT,ST2,O1,DOT,
102,SV1,SV2,DOT,SV3,TYP
WRITE(7,95) D,SGN,T1,DOT,T2,NB,T22,S1,DOT,S2,ST1,DOT,ST2,O1,DOT,
102,SV1,SV2,DOT,SV3,TYP
95 FORMAT(T9,A4,T18,A1,A2,4A1,T30,A2,A1,A3,T39,A2,A1,A2,T49,A1,A1,
1A2,T57,A1,A3,A1,A1,T66,I1)
90 NPG=NPG+1
GO TO 27
C -----END OF DATA-READ LOOP
C -----END OF MAIN LOOP
190 IF(K.EQ.0) GO TO 192
WRITE(6,191) K,CC,SH,LATD,LATM,LOND,LONM,ID1,ID2,TYP
191 FORMAT(//5X,'READ ERROR IN SKIP LOOP: CONTINUE. K= ',I6/)
K=K+1
GO TO 8
192 WRITE(6,193)NREC
193 FORMAT(//5X,'READ ERROR IN DATA-READ LOOP: CONTINUE. NREC= ',I6/)
NREC=NREC+1
GO TO 27
194 WRITE(6,195)

```



```

C      GO TO 999
      160 IF(1B.GE.TC3)GO TO 165
          IANS=0
          GO TO 999
      165 IF(1B.LE.TC4)GO TO 999
          IANS=0
          RETURN
      999 END
      //GO.FT04F001 DD UN IT=3400-4,VOL=SER=NP S688,DISP=(OLD,KEEP),
      // DCB=(DEN=2,RECFM=FB,LRECL=80,BLKSIZE=3200),LAPEL=(1,SL,IN),
      // DSN=S2514.NDC2
      //GO.SYSIN DD *
      (10A4,4X,11,4X,11,1X,12,2X,11,1X,A4,A4,16,5X)
      (20X,12,12,56X)
      (1X,TC1=',I2,',TC2=',I2,',TC3=',A4,',TC4=',A4)

```

085682

*****NODCRD,MOD.3*****

R.G. PAQUETTE, 11 OCT 78

READS SELECTED STATIONS FROM NODC TAPE. THESE STATIONS MAY BE SELECTED AS FOLLOWS:

- A. BY DIRECT COMPARISON OF ONE FIELD(4 CHARACTERS MAX.) WITH A TEST CONSTANT IN A-FORMAT.
- B. SAME AS A. BUT WITH TWO FIELDS.
- C. EITHER OR BOTH FIELDS IN A AND B MAY BE TESTED BY .GE.IX OR .GE.IX.AND.LE.IV TYPE OF CRITERIA IN I-FORMAT.

CARD INPUT AND INSTRUCTIONS ARE CODED AS FOLLOWS.

CARD NO.1 : 80 BYTES OF FORMAT FOR READING CARD NO. 2. TYPICALLY FOR ONE A-FORMAT COMPARISON FIELD, ONE BLANK, AND TWO INTEGERS:

(10A4,4X,11,4X,11,1X,A2,2X,A4,11,1X,14,14,16,5X)

CARD NO.2 : 40 BYTES OF VARIABLE FORMAT FOR READING THE TEST VARIABLES 1A AND 1B FROM TAPE. ALWAYS SPECIFY TWO, EVEN THOUGH YOU MAY ONLY USE THE FIRST. IN COLUMN 45 (MD3) PUT A ZERO OR BLANK IF ONE TEST VARIABLE IS TO BE USED; ANY OTHER NUMERAL WILL INDICATE TWO TEST FIELDS. IN COLUMN 50 (MD1) A ZERO OR BLANK INDICATES PURE CHARACTER RECOGNITION. 1. INDICATES .GE. A SINGLE CONSTANT, A 2. INDICATES .GE. TEST CONSTANT NO. 1, TC1, AND .LE. TC2; TC1 AND TC2 ARE ENTERED IN COLUMNS 52-55 AND (IF APPROPRIATE) 56-59. THE SECOND GROUP (SINGLE OR DOUBLE) OF TEST CONSTANTS IS CODED SIMILARLY IN COLUMNS 60-69. COLUMN 60 (MD2) IS LIKE 50. TC3 AND (IF APPROPRIATE) TC4 ARE ENTERED IN 62-65 AND 66-69 RESPECTIVELY. COLUMNS 70-75 CONTAIN AN INTEGER SPECIFYING THE NUMBER OF RECORDS TO BE SKIPPED BEFORE PROCESSING; IF BLANK, NO SKIPS.

CARD NO. 3 : 40 BYTES FOR ENTERING A FORMAT FOR WRITING THE TEST CONSTANTS, E.G.:

(1X, TC1=, A3, , TC2=, A4, , TC3=, I4, TC4=, I4)

NOTE SOME MANIPULATIONS TO RECOVER THE MINUS SIGN IN TEMPERATURE WHICH APPEARS AS AN 11 OR 12 PUNCH IN THE FOURTH DIGIT

DIMENSION FMT1(10), FMT2(20), FMT(20), HDRI(19)
INTEGER CC, YR, DAY, HR, STANO, DPTH, SDTH, TYP, T21, F1, D1, ZE, TC1, TC2, TC3, TC4


```

DATA SGN1/' ',SGN2/'-'/,F1/ZF0404040/,D1/ZC0404040/,
IZE/Z50404040/,SV1/'1'/',DOT/'.'/'

C
CALL REREAD
REWIND 4
WRITE(6,6)
6 FORMAT(///)
C
C N IS THE NUMBER OF HEADERS PRINTED,NN IS THE NUMBER OF HEADERS READ,
C NPG IS THE COUNT OF NUMBER OF LINES PRINTED ON PAGE,NOPAGE IS THE
C PAGE NUMBER,NREC IS THE NUMBER OF RECORDS READ
NCPAGE=2
N=0
NN=0
NPG=0
NRD=0

C
C READ FORMATS, ETC
C
400 READ(5,400)FMT
FORMAT(20A4)
401 WRITE(6,401)FMT
FORMAT(1X,'FMT=',20A4)
402 READ(5,FMT)FMT1,MD3,MD1,TC1,TC2,MC2,TC3,TC4,ND
WRITE(6,402)FMT1,MD1,MD2,ND,MD3
403 FORMAT(1X,'FORMAT FOR READING TEST VARIABLES FROM TAPE,MODE1,MODE2
1,THE NUMBER OF RECORDS TO BE SKIPPED,AND MODE3 ARE:',/1X,10A4,2I5,
110,15)
404 READ(5,403)FMT2
FORMAT(20A4)
405 WRITE(6,FMT2)TC1,TC2,TC3,TC4
C
C SKIP DIRECTLY TO PRINTING DATA, IF THERE IS NONE TO BE SKIPPED.
K=0
NREC=0
77 IF(ND.EQ.0)GO TO 99
C
C READ THE UNWANTED DATA
K=1
8 READ(4,9,END=200,ERR=190)
9 FORMAT(79X,11)
IF(K.GE.ND) GO TO 99
K=K+1
GO TO 8
C
C END OF UNWANTED DATA LOOP
99 NREC=K
C
C NOPAGE=NOPAGE+1

```



```

C      NPG=NPG+2
      WRITE(6,25)
      FORMAT(18,'DEPTH',T15,'TEMPERATURE',T28,'SALINITY',T38,'SIGMA-T',
1T48,'OXYGEN',T59,'SV',T64,'TYPE'//)
      NPG=NPG+2

C      27 NREC=NREC+1
      READ DATA
      READ(4,30,END=200,ERR=192) D,T1,T2,T21, T22,S1,S2,ST1,ST2,
1SV2,SV3,O1,O2,TYP
      30 FORMAT(T28,A4,I4,A2,A3,A2,A2,T47,A3,A1,A1,A2,T80,I1)
      IF(TYP,NE.1)GO TO 31
      NN=NN+1
      PRINT ABOUT 75 LINES ON A PAGE
      IF(NPG.LE.50)GO TO 32
      NPAGE=NPAGE+1
      NPG=0
      WRITE(6,50)
      WRITE(6,3)NPAGE
      32 READ(99,FMT1)IA,IB
      CALL TEST(IANS,MD1,MD2,MD3,TC1,TC2,TC3,TC4,IA,IB)
      IF(IANS.NE.1)GO TO 11
      READ(99,10)CC,SH,LATD,LATM,LOND,LONM,MSQ,YR,MO,DAY,HR,CRNO,STANO,
1DEPTH,SDTH,NBS,STA2,ID1,ID2,TYP
      GO TO 12
      WE EXAMINE T21, WHICH HAS AN OVERPUNCH FOR A MINUS SIGN,
      BECOMING D1,D2,ETC. AND DO INSTEAD OF F1,F2, AND F0. ZERO, THE
      WE START BY SUBTRACTING ZFO. IF THE RESULT IS .GT. ZERO, THE
      DIGIT HAD NO OVERPUNCH AND WE RECREATE THE DIGIT. IF THE
      RESULT IS .LT. ZERO, WE SUPPLY THE MINUS SIGN, FIND OUT IF IT WAS
      A DIGIT .GT. ZERO BY A SIMILAR PROCEDURE, ETC.
      31 NR=T21-F1
      IF(NB.GE.0) GO TO 33
      SIGN MUST BE NEGATIVE.
      SGN=SGN2
      RECREATE ORIGINAL DIGIT AND SUBTRACT ZD0: THIS ALSO CONVERTS
      A Z50 INTO A 1000000, A -0.
      NB=NR+F1-D1
      IF(NB.GE.0) GO TO 35
      RECREATE DIGIT IF IT WAS NOT AMONG 0 TO 9 AND PRINT IT UNCHANGED.
      NB=NB+D1
      GO TO 37
      SGN=SGN1
      33 SGN=SGN1
      35 NB=NB+F1
      37 WRITE(6,95) D,SGN,T1,DOT,T2,NB,T22,S1,DOT,S2,ST1,DOT,ST2,O1,DOT,
1O2,SV1,SV2,DOT,SV3,TYP
      95 FORMAT(T9,A4,T18,A1,A2,4A1,T30,A2,A1,A3,T39,A2,A1,A2,T49,A1,A1,

```



```

1A2,T57,A1,A3,A1,A1,T66,I1)
90 NPG=NPG+1
GO TO 27
-----END OF DATA-READ LOOP
-----END OF MAIN LOOP

190 IF(K.EQ.0) GO TO 192
WRITE(6,191) K,CC,SH,LATD,LONM,LOD,LONM,LOD1,ID2,TYP
191 K=K+1
GO TO 8
192 WRITE(6,193)NREC
193 FORMAT(/5X,'READ ERROR IN DATA-READ LOOP; CONTINUE. NREC= ',I6/)
NREC=NREC+1
GO TO 27
194 WRITE(6,195)
195 FORMAT(/5X,' END OF ATLANTIC OCEAN DATA ')
GO TO 999
200 WRITE(6,205)
205 FORMAT(/5X,'END OF FILE')
999 STOP
END

SUBROUTINE TEST
DOES THE TESTING FOR NODCRD MOD. 3

SUBROUTINE TEST(IANS,MD1,MD2,MD3,TC1,TC2,TC3,TC4,IA,IB)

TEST THE FIRST FIELD

INTEGER TC1,TC2,TC3,TC4
IF(MD1-1)20,40,60
20 IF(IA.EQ.TC1)GO TO 30
IANS=0
GO TO 999
30 IANS=1
IF(MD3.EQ.0)GO TO 999
GO TO 100
40 IF(IA.GE.TC1)GO TO 50
IANS=0
GO TO 999
50 IANS=1
IF(MD3.EQ.0)GO TO 999
GO TO 100

```



```

60 IF(IA.GE.TC1)GO TO 65
   IANS=0
   GO TO 999
65 IF(IA.LE.TC2)GO TO 70
   IANS=0
   GO TO 999
70 IANS=1
   IF(MD3.EQ.0)GJ TO 999
      MD3.NE.0; TEST A SECOND FIELD
C
C
100 IF(MD2-1)120,140,160
120 IF(IB.EQ.TC3)GJ TO 999
   IANS=0
   GO TO 999
140 IF(IB.GE.TC3)GJ TO 999
   IANS=0
   GO TO 999
C
160 IF(IB.GE.TC3)GO TO 165
   IANS=0
   GO TO 999
165 IF(IB.LE.TC4)GO TO 999
   IANS=0
   GO TO 999
C
999 RETURN
      END
//GO.FT04F001 DD UNIT=3400-4,VOL=SER=NPS688,DISP=(OLD,KEEP),
// DCB=(DEN=2,RECFM=FB,LRECL=80,BLKSIZE=3200),LABEL={1,SL,I,N},
// DSN=S2514.NDC2
//GO.SYSIN DD
(10A,4X,11,4X,11,1X,12,2X,11,1X,A4,A4,I6,5X)
(20X,12,12,56X)
(1X,TC1=,I2,,TC2=,I2,,TC3=,A4,,TC4=,A4)

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087890

[illegible]

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ADAPTATION OF CHPTPLT MOD 2 TO PLOT POSITION AND
SYMBOLS FOR NOSE (N), SHALLOW FINE STRUCTURE (S, 3 WEIGHTS), DEEP
FINE STRUCTURE (D, 3 WEIGHTS). IN ADDITION TO STATION IDENTIFYING
INFORMATION AND POSITION THE DATA CARD HAS 3 ONE-BYTE VARIABLES:
JN, JS, JD FOR NOSE (0=NO NOSE), SHALLOW STRUCTURE (0=NONE,
1=WEAK, 2=MEDIUM, 3=STRONG), DEEP STRUCTURE CODED LIKE SHALLOW.
WE PLOT POSITION WITH A 0.14 CROSS, NOSE WITH A .07 N TO THE LEFT,
SHALLOW STRUCTURE AS S (STRONG), M (MEDIUM) AND W (WEAK) IN
0.07 SIZE ABOVE; DEEP FINE STRUCTURE SIMILARLY, TO THE RIGHT, IN .14 SIZE.
TO READ JD ONLY: CHANGE FMT CARD FROM (...30X, 311) TO (...30X, 11, 2X, 211).
(...28X, 211, 2X, 11). TO READ JN ONLY: CHANGE TO (...30X, 11, 1X, 11).
TO READ JS ONLY: CHANGE TO (...33X, 311).
ONLY CHANGE TO (...33X, 311).
ONE READ SALINITY AND POSITION FROM A SINGLE CARD.

```

ONE! CHANGE IS A... POSITION FROM A SINGLE CARD.
WE READ SALINITY AND POSITION FROM A SINGLE CARD.

ALSO WE READ A VARIABLE FORMAT FMT
THIS MODIFIES CHPTLT MOD. LA TO PLOT ON A MERCATOR PROJECTION
(OR ANY OTHER PROJECTION WITH APPROPRIATE SUBROUTINE). ALL THE
PRECEDING VARIABLES ARE USED BUT WE ADD TWO MORE TO &CTRL:
XLGTH, THE LENGTH IN INCHES OF ONE DEGREE OF LONGITUDE AND SHRK,
A FACTOR CORRECTION TO THE LATITUDE SCALE TO ALLOW FOR UNEVEN
SHRINKAGE OF THE PAPER OF THE CHART.
PROGRAM CHPTLT TO PLOT CONIC PROJECTION CHART OF STATION
THIS MOD ADDS STATION STORAGE AND REDUCES TRACK STORAGE.
POSITIONS FOR A SMALL AREA

WE CONVERT LATITUDES AND LONGITUDES FOR PLOTTING, USING A APPROX-
IMATION TO THE LAMBERT PROJECTION, PROJECTING ON A CONE TANGENT
TO THE SPHERE AT MID-LATITUDE, XMDLAT. WE CENTER THE PLOT ON
LONGITUDE XMDLO SUCH THAT THE RANGE OF LONGITUDE, RNGL0, CONVERTS
TO 10 INCHES OF PLOT WIDTH AT THE LOWEST LATITUDE, USED, XLATO.
LOGICAL VARIABLES STA AND TRK, IF TRUE, PERMIT COORDINATES AND P
PRINTING STATION COORDINATES AND TRACK COORDINATES. IF PLT
ALSO IS TRUE, STATION POSITIONS AND CRUISE TRACK ARE PLOTTED BOTH
ON THE PLOTTER. STATION POSITIONS ARE PLOTTED WITH
ASTERISKS AND INTERCONNECTING LINES. THE TRACK IS PLOTTED
AS A LINE WITH DOTS EVERY 12TH ENTRY. THE COAST (PERSECTIONS OF
18 POINTS) IS PLOTTED EACH WITH EACH AS WELL AS THE INTERSECTIONS OF THE
EACH DEGREE OF LONGITUDE WITH EACH HALF-DEGREE OF LATITUDE. FOR
ARRAY IS GENERATED FOR A PARTICULAR AREA AND MUST BE REVISED FOR
OTHER AREAS. INPUT DATA CONSISTS OF TWO NAMELISTS AND A SET OF
CONVENTIONAL DATA CARDS FOR EITHER THE STATIONS OR THE TRACK,
ALTHOUGH ONE COULD PLOT BOTH IF HE DIDN'T MIND THE MESS.
MODIFIED FOR VERSATEC(FORTCLGV) 19 SEPT 78. NOW PERMITS NEGATIVE


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C LONGITUDES(E LONG.). PLOTS LONGITUDE ON THE PAPER WIDTH. NOTE: N-S
C LIMIT OF 21 INCHES AND E-W LIMIT OF 21 INCHES(CAN BE CHANGED BY JCL).
C SCALING IS DONE CONCEPTUALLY WITH XLONGO AS THE X ZERO IN
C MIDSCALE. XLONGO IS AUTOMATICALLY SET= XMDLO. SETTING XLFSPC
C THE X-OFFSET AT ABOUT PAPER CENTER(10.5 INCHES- INITIALIZED)
C PERMITS PLOTTING EITHER SIDE OF XMDLO TO A MAXIMUM OF 10.5 IN.
C IF THE DEFAULT X LIMIT IS TO BE EXCEEDED ANOTHER LARGER CHOICE
C CF XLFSPC SHOULD BE MADE.

C DIMENSION CSTLA(400),CSTLO(400),CCRLA(200),CORLO(200),XMDLO(240),
1STALA(240),STALO(240),XMLA(240),TRLA(480),YMLA(480),TRLO(480),
2YMDLO(480),TRKA(40),TRKO(40),CORLA(200),CORLO(200),IST(15),
3ICST(15),NPLT(15),FMT(20),SH(240),YR(240),STA(240)
C INTEGER #2 JN(240),JS(240),JD(240)
C EQUIVALENCE (CORLA(1),CORLA(1)),(CORLO(1),CORLO(1))
C LOGICAL STAN,TRAK,PLT,CST,STAD,TRKD
C NAMELIST /COAST/CSTLA,NC,CSTLO/CONTRL/ISTOP,STAN,TRAK,NSTA,NTRK,
1PLT,XLATO,XMDLAT,XMDLO,RNGLO,W,XLFSPC,DELLA,DELLO,JSTART,JFINSH,
2STAD,TRKD,CST,XLNGTH,SHRK/LIMIT/XLIM1,XLIM2,YLIM1,YLIM2

C ISTOP=0
C XLFSPC=10.5
C STAN=.TRUE.
C STAD=.FALSE.
C TRKD=.TRUE.
C TRAK=.FALSE.
C PLT=.FALSE.
C CST=.FALSE.
C RAD=3.14159/180.
C SHRK=1.

C ZERO ARRAYS
DO 4 J=1,400
CSTLA(J)=0.
CSTLO(J)=0.
4 DC 401 J=1,200
CORLA(J)=0.
401 CORLO(J)=0.

C INPUT & CONTROL & LIMIT & FMT & COAST
5 READ(5,CONTRL)
C XLONGO=XMDLO
C WRITE(6,CONTRL)
C IF(ISTOP.GT.0) GO TO 999
C READ(5,LIMIT)
C WRITE(6,LIMIT)
C READ(5,402) FMT
C WRITE(6,403)FMT

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```

402 FORMAT(20A4)
403 FORMAT(1X,20A4)
IF(.NOT.CST) GO TO 6
READ(5,COAST)
COUNT THE ENTRIES
C
J=1
551 IF(CSTLA(J).LT..01) GO TO 553
J=J+1
GO TO 551
553 J=J-1
NCLA=J
WRITE(6,556) NCLA
556 FORMAT(75X,'NCLA= ',I4)
WRITE(6,557)
557 FORMAT(7/25X,'LAT AND LONG OF COAST COORDINATES'//)
WRITE COAST ARRAYS.
WRITE(6,57)(CSTLA(J),J=1,NCLA)
57 FORMAT(7(1X,F7.3,F8.3))
C
C*****READ STATION DATA*****
C
6 IF(.NOT.STAN) GO TO 30
WRITE(6,53)
53 FORMAT(11)
INPUT OF STATION COORDINATES REQUIRES UP TO 240 CARDS, ONE SET OF
COORDINATES TO A CARD, NORMALLY IN DEGREES, MINUTES AND TENTHS,
BUT MAY BE IN DEGREES AND DECIMALS IF STAD=T.
FORMAT IS VARIABLE. WE ALSO READ SALINITY. STOP READING ON BLANK
CARD. *****
J=1
11 READ(5,FMT)STALA(J),XMLA(J),STALO(J),XMLO(J),YR(J),STA(J),
1JN(J),JD(J),JS(J)
IF(STALA(J).EQ.0.)GO TO 110
J=J+1
GO TO 11
110 J=J-1
NCARDS=J
NSTA=J
WRITE(6,112) J,YR(J),STA(J),STALA(J),XMLA(J),STALO(J),XMLO(J),
1JN(J),JS(J),JD(J)
112 FORMAT(7/3X,'LAST VALUE OF J,YR,STA,STALA,XMLA,STALO,XMLO,JN,JS,
1JD:',7/3X,I3,1X,A2,1X,A4,4F5.1,1X,3(1X,I1)/)
XMNI=60.
IF(STAD) XMNI=100.
DO 20 J=1,NSTA
STALA(J)=STALA(J)+XMLA(J)/XMNI
IF(STALO(J).GE.0)GO TO 19
STALO(J)=STALO(J)-XMLO(J)/XMNI

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GO TO 20
STALO(J)=STALO(J)+XMLO(J)/XMIN1
20 CONTINUE
201 WRITE(6,53)
21 FORMAT(1, J, STA YR STALA STALO JN JS JD'')
DO 210 J=1, NCARDS
210 WRITE(6,22) J, STA(J), YR(J), STALA(J), STALO(J), JN(J), JS(J), JD(J)
22 FORMAT(3X, I5, 1X, A4, 1X, A2, 2F9.3, 3(2X, I1))
22 FORMAT(2(3X, I3, 2X, A2, A4, 2X, 2F8.3, 1X, F5.1)) FOR INTGST
*****
READ TRACK COORDINATES IN SAME FORM AS STATION COORDS. AND
CONVERT TO DECIMAL.
30 IF(.NOT. TRK) GO TO 50
READ(5, 10) (TRLA(J), YMLA(J), TRLO(J), YMLO(J), J=1, NTRK)
10 FORMAT(6(F3.0, F3.1, F3.0, F3.1))
WRITE(6, 53)
12 WRITE(6, 12) (TRLA(J), YMLA(J), TRLO(J), YMLO(J), J=1, NTRK)
12 FORMAT(3(5X, F4.0, 1X, F4.1, 5X, F4.0, 1X, F4.1))
XMIN2=60.
IF( TRK ) XMIN2=100.
DO 40 J=1, NTRK
TRLA(J)=TRLA(J)+YMLA(J)/XMIN2
40 TRLO(J)=TRLO(J)+YMLO(J)/XMIN2
WRITE(6, 53)
42 CONTINUE
*****
CREATE COORDINATE FIELD *****
50 XLAO=XLAT0-DELLA
XLOB=XMDLO-RNGLO/2.-DELLO
FIND LOOP PARAMETERS
XJLAT=(XMDLAT-XLAT0)/DELLA*2.+*.01
JLAT=FIX(XJLAT)+1
TEST TO SEE THAT THE RANGE IN LATITUDE IS AN INTEGRAL
NUMBER OF DELLA UNITS, AND SIMILARLY FOR LONGITUDE.
XJLAT1=JLAT
IF((XJLAT-XJLAT1).GT.1.05) WRITE(6, 51) XJLAT
51 FORMAT(5X, 'WARNING*****. COUNT OF COORDINATES IS IMPROPER--XLAT
1, JLAT= ', F5.2, I5)
XJLO=RNGL0/DELL0+1.01
JLO=FIX(XJLO)
XJLO1=FL0AT(JLO)
IF((XJLO-XJLO1).GT.0.05) WRITE(6, 510) XJLO, JLO
510 FORMAT(5X, 'WARNING*****COUNT OF LONGITUDE LEVELS NOT CONSISTENT

```



```

C
C      IWITH DELLO.  XJLO,JLO= ',F5.2,I5)
C      TEST TO SEE IF JLAT*JLO IN RANGE
C      NCOORD=JLAT*JLO
C      IF(NCOORD.LE.200) GO TO 512
C      WRITE(6,511) NCOORD
511  FORMAT(/IX,'XXXXXX STORAGE EXCEEDED FOR COORDINATES; NCOORD= ',I5)
C      GC TO 999
512  WRITE(6,513)
513  FORMAT(/30X,'COORDINATE FIELD, LAT AND LONG'/)
C      DO 52 J=1,JLAT
C      XLAO=XLAO+DELLA
C      DO 52 K=1,JLO
C      XK=FLOAT(K)*DELLO
C      L=(J-1)*JLO+K
C      CORLA(L)=XLAO
C      CORLO(L)=XLCB+XK
C      CONTINUE
52  SCAN LONGITUDES FOR .GT. 180 AND TRANSFORM TO NEGATIVE LONGS.
C      DO 540 J=1,NCOORD
C      IF(CORLO(J).GT.180.) CORLO(J)=CORLC(J)-360.
540  CONTINUE
C      WRITE(6,55) (CORLA(J),CORLO(J),J=1,L)
55  FORMAT(5(3X,F5.2,1X,F7.2))
C      WRITE(6,53)
C      WRITE(6,56) NCOORD
56  FORMAT(5X,'NCOORD= ',I5)
C      WRITE(6,53)
C*****
C      PLOT
C      IF(.NOT.PLT) GO TO 90
C      CALL PLOTS
C      CALL PLOT(0.,2.,-3)
90  CONTINUE
C
C      COMPUTE CONSTANTS
C      PI2=3.14159/2.
C*****
C      CALL SCLCHT(CORLA,CORLO,NCOORD,XLGTH,XLFSPC,SHRK,XLATO,XLONGO)
C      WRITE(6,53)
C      WRITE(6,1015)
1015  FORMAT(/15X,'SCALED CROSS COORDINATES, Y, X'//)
C      WRITE(6,1020) (CORLA(J),CORLO(J),J=1,NCOORD)
1020  FORMAT(4(2X,E11.4,1X,E11.4))

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```

C      TEST FOR OUT OF RANGE VALUES
DO 1021 J=1,NCOORD
  IF(CORLA1(J).LT.YLIM1) CORLA1(J)=YLIM1
  IF(CORLA1(J).GT.YLIM2) CORLA1(J)=YLIM2
  IF(CORLO1(J).GT.XLIM2) CORLO1(J)=XLIM2
  IF(CORLO1(J).LT.XLIM1) CORLO1(J)=XLIM1
1021 IF(.NOT.PLT) GO TO 1030
  MCOORD=-NCOORD
  CALL LINE(CORLO1,CORLA1,NCOORD,1,-5)
  IPLACE=1021
  WRITE(6,2000) IPLACE
2000 FORMAT(5X,'IPLACE=',I5/)
  CALL PLOTP(CORLO1,CORLA1,MCOORD,1)
C*****END COORDINATE FIELD*****
C      COMPUTE COAST COORDINATES AND PLCT
1030 IF(.NOT.CST) GO TO 1060
  EXAMINE THE COAST COORDINATES AND FIND THE INDEXES OF THE SEGMENTS
  SEPARATED BY LAT=99. THE ARRAY MUST END WITH LAT=99 AND THE
  FOLLOWING LATITUDE=00. WE ALSO CONSTRUCT THE ARRAY SO THAT
  THERE ARE POINTS ON THE EVEN DEGREES AND HALF DEGREES OF LATI-
  TUDE, OR LONGITUDE IF THE COAST IS MAINLY E-W. THIS MAKES IT
  CONVENIENT TO SET UP FOR DIFFERENT LATITUDE AND LONGITUDE RANGES.
  WE CAN USE ONLY PART OF THE ARRAY BY SPECIFYING JSTART AND JFINSH
  J=JSTART
  K=1
1032 IF(CSTLA(J).GT.91) GO TO 1034
  IF(J.GE.JFINSH) GO TO 1035
  J=J+1
  GO TO 1032
1034 ICST(K)=J
  RESET THE DELIMITERS TO VALUES WHICH DO NOT BLOW UP IN ALOG.
  CSTLA(J)=89.
  CSTLO(J)=1.
  CSLAJ1=CSTLA(J+1)
  IF THE NEXT ONE IS BLANK, IT IS THE END OF THE ARRAY.
  IF(CSLAJ1.LT..1) GO TO 1035
  J=J+1
  K=K+1
  IF(K.GT.15) GO TO 1038
  GO TO 1032
1035 NSEG=K
  IF THERE ARE FEWER VALUES THAN EXPECTED, CHANGE JFINSH.
  ICST(K)=J
  NSEG=K
  JFINSH=J
1037 WRITE(6,1036) NSEG,(ICST(K),K=1,NSEG)

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1036 FORMAT(/5X,'COAST ARRAY CONSISTS OF ',I2,' SEGMENTS ENDING ON NUMB
IERS ',10I4/)
GO TO 1040
1038 WRITE(6,1039)
1039 FORMAT(5X,'EXCEEDED THE LIMIT OF THE ICST ARRAY')
NSEG=K-1
JFINSH=J-1
GO TO 1037
1040 CONTINUE
NCT=JFINSH-JSTART+1
CALL SCLCHT(CSTLA(JSTART),CSTLO(JSTART),NCT,XLGTH,XLFSPC,SHRK,
1X,LATO,XLNGO)
TEST FOR OUT OF RANGE VALUES
DO 1041 J=JSTART,JFINSH
IF(CSTLA(J).LT.YLIM1) CSTLA(J)=YLIM1
IF(CSTLA(J).GT.YLIM2) CSTLA(J)=YLIM2
IF(CSTLO(J).GT.XLIM2) CSTLO(J)=XLIM2
IF(CSTLO(J).LT.XLIM1) CSTLO(J)=XLIM1
1041 WRITE(6,1043)
1043 FORMAT(/15X,'SCALED COAST COORDINATES,Y, X'//)
WRITE(6,1020)(CSTLA(J),CSTLO(J),J=JSTART,JFINSH)
1042 FORMAT(6(2X,E11.4))
WRITE(6,53)
IF(.NOT.PLT) GO TO 1060

C      THE NEXT ROUTINE PLOTS THE COAST IN SEGMENTS
C      COMPUTE THE NUMBER OF POINTS TO BE PLOTTED BEFORE THE PEN IS
C      LIFTED (NPLT) AND THE START OF EACH SEQUENCE (IST)
NPLT(1)=ICST(1)-JSTART
IST(1)=JSTART
DO 1046 J=2,NSEG
NPLT(J)=ICST(J)-ICST(J-1)-1
IST(J)=ICST(J-1)+1
1046 M=2
IF(.NOT.STAN.AND..NOT.TRAK) M=3
DO 1047 J=1,NSEG
IA=IST(J)
NC=NPLT(J)
IB=-NC
IPLACE=1046
WRITE(6,2000) IPLACE
CALL PLOTP(CSTLO(IA),CSTLA(IA),IB,M)
1047 CALL LINE(CSTLO(IA),CSTLA(IA),NC,1,1)
IF(.NOT.STAN) GO TO 107

C*****
C*****SCALE AND PLOT STATIONS*****
C
1060 CONTINUE

```



```

CALL SCLCHT(STALA,STALO,NSTA, XLGTH,XLFSPC,SHRK,XLATD,XLONGD)
WRITE(6,1062)
FORMAT(//15X,'SCALED STATION COORDINATES, Y, X'//)
WRITE(6,1020)(STALA(J),STALO(J),J=1,NSTA)
THROW THE POINTS OUT OF LIMITS. COUNT TOTAL POINTS WITH J,
GOOD POINTS WITH K
J=0
K=1
1064 J=J+1
IF(J.GT.NSTA) GO TO 1065
IF(STALO(J).LT.XLIM1) GO TO 1064
IF(STALO(J).GT.XLIM2) GO TO 1064
IF(STALA(J).GT.YLIM2) GO TO 1064
IF(STALA(J).LT.YLIM1) GO TO 1064
STALO(K)=STALO(J)
STALA(K)=STALA(J)
JN(K)=JN(J)
JS(K)=JS(J)
JD(K)=JD(J)
K=K+1
GO TO 1064
1065 NCARDS=K-1
NSTA=NCARDS
C
KD=J-K
WRITE(6,1066) KD
FORMAT(3X,'DISCARDED ',I3,' STATIONS')
IF(.NOT.PLT) GO TO 107
DO 1063 J=1,NCARDS
PLOT POSITION
XP=STALO(J)-0.045
YP=STALA(J)-0.08
XFI=XP+.07
CALL SYMBOL(XP,YP,.14,'+',0.,1)
PLOT NOSE SYMBOL
IF(JN(J).EQ.0) GO TO 1067
XP=STALO(J)-0.14
YP=STALA(J)-0.35
CALL SYMBOL(XP,YP,.07,'N',0.,1)
PLOT SHALLOW SYMBOL
IF(JS(J).EQ.0) GO TO 1071
XP=STALO(J)-0.035
YP=STALA(J)+0.09
IF(JS(J).GT.1) GO TO 1069
CALL SYMBOL(XP,YP,.07,'A',0.,1)
GO TO 1071
1067
1069 IF(JS(J).GT.2) GO TO 1070
CALL SYMBOL(XP,YP,.07,'B',0.,1)

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1070 GC TO 1071
C CALL SYMBOL(XP,YP,.07,'C',0.,1)
PLOT DEEP SYMBOL
1071 IF(JD(J).EQ.0) GO TO 1063
XP=STALO(J)+0.08
YP=STALA(J)-0.07
IF(JD(J).GT.1) GO TO 1073
CALL SYMBOL(XP,YP,.14,'A',0.,1)
GO TO 1063
1073 IF(JD(J).GT.2) GO TO 1074
CALL SYMBOL(XP,YP,.14,'B',0.,1)
GO TO 1063
1074 CALL SYMBOL(XP,YP,.14,'C',0.,1)
1063 CONTINUE
IF(.NOT. TRAK) M=3
IB=-NSTA
IPLACE=1061
WRITE(6,2000) IPLACE
CALL PLOTP(STALO,STALA,IB,M)
107 IF(.NOT. TRAK) GO TO 120
C *****END *****STATION *****
C
1080 CONTINUE
CALL SCCLCHT(TRLA,TRLO,NTRK, XLGTH,XLFSPC,SHRK,XLATO,XLONGO)
WRITE(6,53)
TEST FOR OUT OF RANGE VALUES
DO 1081 J=1,NTRK
IF(TRLA(J).LT.XLIM1) TRLA(J)=XLIM1
IF(TRLA(J).GT.YLIM2) TRLA(J)=YLIM2
IF(TRLO(J).LT.XLIM1) TRLO(J)=XLIM1
IF(TRLO(J).GT.XLIM2) TRLO(J)=XLIM2
WRITE(6,1082)
1081 FORMAT(//, 'SCALED TRACK COORDINATES, Y, X'//)
WRITE(6,1020)(TRLA(J),TRLO(J),J=1,NTRK)
IF(.NOT. PLT) GO TO 1100
CALL LINE(TRLO,TRLA,NTRK,1,1)
C
C PUT MARKS IN EVERY 12 POINTS
NTRK1=NTRK/12
DO 1100 J=1,NTRK1
KK=12*(J-1)+1
TRKA(J)=TRLA(KK)
TRKO(J)=TRLO(KK)
WRITE(6,53)
1100 WRITE(6,1042)(TRKA(J),J=1,NTRK1)
WRITE(6,53)
WRITE(6,1042)(TRKO(J),J=1,NTRK1)

```



```

C      IF(.NOT.PLT) GO TO 998
C      CALL LINE(TRKO,TRKA,NTRK1,1,-3)
C      IB=-NTRK1
C      CALL PLOT P(TRKO,TRKA,IB,3)

C      PUT IN A LABEL
120  YLB=YLM2+1.
C      CALL SYMBOL(0.,YLB,.28,'R.H.BOURKE-BOX 110',0.,19)

C      RESET PEN
C      YLB=YLM2+4.
C      CALL PLOT(0.,YLB,-3)

C      TERMINATE PLOT
C      CALL PLOTE
C      WRITE(6,990)
990  FORMAT(/3X,'PLOT SHOULD BE COMPLETED')
998  GO TO 5
999  STOP
END

C      ----- SUBROUTINE SCLCHT -----
C      THIS SUBROUTINE IS FOR USE WITH CHTPLT, MOD. 2. IT ACCEPTS
C      COORDINATE PAIRS IN THE ORDER LATITUDE, LONGITUDE, IN DEGREES AND
C      DECIMAL FRACTIONS OF A DEGREE AND RETURNS TO THE SAME ARRAYS
C      PLOTTING COORDINATES IN INCHES FOR A MERCATOR PROJECTION. Y IS
C      THE LATITUDE ARRAY, X THE LONGITUDE ARRAY, N IS THE NUMBER OF
C      POINTS IN THE ARRAY, XLGTH IS THE LENGTH OF ONE DEGREE OF LONGI-
C      TITUDE IN INCHES AND SHRK IS A CORRECTION FACTOR TO CORRECT FOR
C      UNEVEN PAPER STRETCH OR SHRINKAGE, APPLIED TO THE LATITUDE SCALE.
C      THE LOWEST LATITUDE IS XLATO AND THE HIGHEST WEST LONGITUDE IS
C      XLONGO, BOTH IN DEGREES.

C      SUBROUTINE SCLCHT(Y,X,N,XLGTH,XLFSPC,SHRK,XLATO,XLONGO)
C      DIMENSION Y(1),X(1)

C      PI=3.141592
C      PI4=PI/4.
C      RAD=PI/180.
C      RAD2=RAD/2.
C      R=XLGTH/RAD
C      R IS THE RADIUS OF THE CYLINDER OF THE PROJECTION.
C      XL=XLATO*RAD2
C      PR=R*SHRK
C      YLATC=ALOG(TAN(XL+PI4))*RR

C      YLATO IS THE DISTANCE IN INCHES FROM THE EQUATOR TO THE BASEE
C      LATITUDE.
C      TRANSFORM THE ARRAYS

```



```

DO 10 J=1,N
  Y(J)=ALOG(TAN(Y(J)*RAD2+PI4))*RR-YLATO
  IF(X(J).GE.0.)GO TO 9
  X(J)=(XLONGO-X(J)-360.)*XLGTH+XLFSPC
  GO TO 10
  9 X(J)=(XLONGO-X(J))*XLGTH+XLFSPC
  10 CONTINUE
  RETURN
END
//GO.SYSIN DD *
&CONTROL PLT=T,XLATO=32.,XMDLO=79.0,RNGLO=4.,XLFSPC=10.5,DELLA=0.25,
DELLLO=0.25,XLGTH=3.9000,SHRK=1.0,XMDLAT=33.0,&END
&LIMIT XLIM1=0.,XLIM2=21.,YLM1=0.,YLM2=21.,&END
(13X,F2.0,F3.1,4X,F4.0,F3.1,3X,A2,8X,A4,1X,3I1)

```


DAV000010
DAV000020
DAV000030
DAV000040
DAV000050
DAV000060
DAV000070
DAV000080
DAV000090
DAV000100
DAV000110
DAV000120
DAV000130
DAV000140
DAV000150
DAV000160
DAV000170
DAV000180
DAV000190
DAV000200
DAV000210
DAV000220
DAV000230
DAV000240
DAV000250
DAV000260
DAV000270
DAV000280
DAV000290
DAV000300
DAV000310
DAV000320
DAV000330
DAV000340
DAV000350
DAV000360
DAV000370
DAV000380
DAV000390
DAV000400
DAV000410
DAV000420
DAV000430
NOD000010
NOD000020
NOD000030
NOD000050

*****NODPUNA*****

SOURCE: ALAN J. PICKRELL/DAVID W. YEAGER
SEPTEMBER 1978

THIS PROGRAM IS DESIGNED TO READ A STANDARD NODC MAGNETIC TAPE AND PUNCH DATA CARDS CONTAINING THE FOLLOWING INFORMATION: LATITUDE OF OCEANOGRAPHIC STATION, LONGITUDE OF STATION, MONTH OF OBSERVATION, NODC IDENTIFICATION CODE, AND LAST 4 DIGITS OF SOUND SPEED VALUE. EACH STANDARD DEPTH FROM 0 TO 400 METERS. THE LEADING DIGIT (A 1) IN THE THOUSANDS PLACE IS NOT PUNCHED. THE PROGRAM VELDAT ASSUMES THAT EACH VALUE READ FROM THESE PUNCHED CARDS MUST HAVE 1000 METERS PER SECOND ADDED TO THE VALUES PUNCHED ON THESE CARDS.

EACH CARD CONTAINS ALL THE ABOVE INFORMATION FOR EACH OCEO STATION OBSERVED.

PUNCH CARD FORMAT FOLLOWS: (3A4, I3, IX, A4, 12(IX, A4))

THESE PUNCH CARDS ARE DESIGNED AS INPUT TO VELDAT FOR ANALYSIS OF SOUND SPEED VARIATION.

TO USE NODPUNA: AFTER FIRST OBTAINING STATION HEADER DUMP WITH PROGRAM NODCDUM, RECORD NO. OF FIRST STATION OF INTEREST IS IFIRST, RECORD NO. OF LAST STATION OF INTEREST IS LASTRC. STATIONS OBSERVED DURING A PARTICULAR MONTH ARE OBTAINED BY SPECIFYING MONTH. THESE SPECIFICATIONS ARE MADE BY PROVIDING THREE INPUT CARDS: IFIRST=XXXXXXX
LASTRC=XXXXXXX
MONTH=XX

AFTER THESE INPUT VARIABLES HAVE BEEN SPECIFIED, PROGRAM WILL READ THE ENTIRE MAGNETIC TAPE, DATA CARDS FOR ALL STATIONS BETWEEN IFIRST AND LASTRC WHICH WERE OBSERVED DURING THE MONTH CORRESPONDING TO THE MONTH SPECIFIED WILL BE PUNCHED.

DIMENSION LALOIN(3), LALOUT(3), VELTAB(12), STDDEP(12)
LOGICAL USING
DATA BLANK/ ' ' /, STDDEP/ '0000', '0010', '0020', '0030',
*, '0050', '0075', '0100', '0150', '0200', '0250', '0300', '0400' /
CALL REREAD


```

MONTH = 12
IFIRST=85700
LASTRC=8789C
REWIND 4
NREC = 1
READ (4,800,END=900,ERR=900)
FORMAT(79X,11)
IF (NREC .GE. IFIRST) GO TO 90
NREC=NREC+1
GO TO 20

```

20
800

C

```

USING = .FALSE.
READ (4,810,END=900,ERR=900) LALOIN,MNTHIN,DEPTH,VEL,IDIN,ICODE
FORMAT(4X,2A4,A3,5X,12,5X,A4,15X,A4,25X,A4,11)
NREC=NREC+1
IF (NREC .GT. LASTRC) GO TO 500
IF (ICODE .NE.1) GO TO 300
IF (USING) WRITE (7,820) LALOUT,MCNTH,IDOUT,VELTAB
FORMAT (3A4,13,1X,A4,12(1X,A4))

```

90
100
810

820
C

```

DO 120 I=1,12
VELTAB(I) = BLANK
USING = .FALSE.
IF (MNTHIN.NE. MONTH) GO TO 100
USING = .TRUE.
LALOUT(1) = LALOIN(1)
LALOUT(2) = LALOIN(2)
LALOUT(3) = LALOIN(3)
IDOUT = IDIN
GO TO 100

```

120

C

C

C

C

```

IF (.NOT. USING) GO TO 100
IF (ICODE .NE. 3 .AND. ICODE .NE. 4 .AND. ICODE .NE. 6) GO TO 100
DO 320 I=1,12
IF (DEPTH .EQ. STDDEP(I)) GO TO 340
CONTINUE
GO TO 100
VELTAB(I) = VEL
GO TO 100

```

300

320

340

C

C

500

```

WRITE (6,830)

```

NOD000090
NOD000100
NOD000110
NOD000120
NOD000130
NOD000140
NOD000150
NOD000160
NOD000170
NOD000180
NOD000190
NOD000200
NOD000210
NOD000220
NOD000230
NOD000240

NOD000260
NOD000270
NOD000280
NOD000290
NOD000300
NOD000310
NOD000320
NOD000330
NOD000340
NOD000350
NOD000360
NOD000370
NOD000380
NOD000390
NOD000400
NOD000410
NOD000420
NOD000430
NOD000440
NOD000450
NOD000460
NOD000470
NOD000480
NOD000490
NOD000500
NOD000510
NOD000520
NOD000530


```

830  FORMAT (' END OF DATA')
      STOP
900  WRITE (6,840)
840  FORMAT (' READ PROBLEM')
      STOP
      END
//GO.FT04F001 DD UN IT=3400-4, VOL=SER=NPS688, DISP=(OLD,KEEP),
//   DCB=(DEN=2, RECFM=FB, LRECL=80, BLKSIZE=3200), LABEL=(1,SL,IN),
//   DSN=S2514.NDC2
//GO.SYSIN DD *
```

```

NOD000540
NOD000550
NOD000560
NOD000570
NOD000580
NOD000590
```


NOD000010
 NOD000020
 NOD000030
 NOD000040
 NOD000050
 NOD000060
 NOD000070
 NOD000080
 NOD000090
 NOD000100
 NOD000110
 NOD000120
 NOD000130
 NOD000140
 NOD000150
 NOD000160
 NOD000170
 NOD000180
 NOD000190
 NOD000200
 NOD000210
 NOD000220
 NOD000230
 NOD000240
 NOD000250
 NOD000260
 NOD000270
 NOD000280
 NOD000290
 NOD000300
 NOD000310
 NOD000320
 NOD000330
 NOD000340
 NOD000350
 NOD000360
 NOD000370
 NOD000380
 NOD000390
 NOD000400
 NOD000410
 NOD000420
 NOD000430
 NOD000440
 NOD000450
 NOD000010
 NOD000020
 NOD000030

*****NODPUNB*****

SOURCE: A.J. PICKRELL/D.W. YEAGER
 SEPTEMBER 1978

THIS PROGRAM IS BASICALLY THE SAME PROGRAM AS NODPUNA.
 IT IS DESIGNED TO READ A STANDARD NODC MAGNETIC TAPE OF
 THE STATION DATA FILE TYPE AND PUNCH DATA CARDS CONTAINING
 THE FOLLOWING INFORMATION: LATITUDE OF STATION, LONGITUDE OF
 STATION, MONTH OF OBSERVATION, NODC IDENTIFICATION CODE, AND
 SALINITY OBSERVED AT EACH STANDARD DEPTH FROM 0 TO 400 METERS.
 SALINITIES ARE PUNCHED IN PARTS PER THOUSAND TO HUNDRETHS
 OF A PPT. NO DECIMAL POINT IS INSERTED BY THIS PROGRAM.
 CARDS ARE DESIGNED AS INPUT TO SALDAT, DECIMAL POINT POSITION
 IS MADE BY SALDAT.

EACH CARD CONTAINS ALL THE ABOVE INFORMATION FOR ONE OCEANOGRAPH-
 IC STATION.

PUNCH CARD FORMAT IS: (3A4,I3,I4,A4,I2(1X,A4))

USE OF NODPUNB IS EXACTLY LIKE NODPUNA: STATIONS ARE ABSTRACTED
 BY MONTH OF OBSERVATION. THREE INPUT CARDS MUST BE SPECIFIED:
 IFIRST=XXXXXXX
 LASTRC=XXXXXXX
 MONTH= XX

IFIRST IS FIRST RECORD NUMBER OF INTEREST ON MAGNETIC TAPE
 (THIS VALUE OBTAINED AFTER EXAMINING OUTPUT OF NODCDUM)
 AND LASTRC IS RECORD NUMBER OF LAST STATION OF INTEREST.
 MONTH (AS BEFORE) IS MONTH OF OBSERVATION DESIRED.

AFTER THESE INPUT VARIABLES HAVE BEEN SPECIFIED, THE PROGRAM
 WILL IGNORE ALL RECORDS PRIOR TO IFIRST. IT WILL THEN READ
 AND PUNCH DATA CARDS FOR ALL STATIONS OBSERVED DURING THE MONTH
 SPECIFIED BETWEEN IFIRST AND LASTRC.

DIMENSION LALOIN(3), LALOUT(3), SALTAB(12), STDDEP(12)
 LOGICAL USING
 DATA BLANK/ 0', STDDEP/ '0000','0010','0020','0030',


```

* 'C050', '0075', '0100', '0150', '0200', '0250', '0300', '0400' /
CALL READ
IFIRST = 85700
LASTRC = 90865
REWIND 4
NREC = 1
READ (4,800,END=900,ERR=900)
FORMAT(79X,11)
IF (NREC.GE. IFIRST) GO TO 90
NREC=NREC+1
GO TO 20

C
C
90
100
810
      USING = .FALSE.
      READ (4,810,END=900,ERR=900) LALOIN,MNTHIN,DEPTH,SAL,IDIN,ICODE
      FORMAT(4X,2A4,A3,5X,12,5X,A4,6X,A4,34X,A4,11)
      NREC=NREC+1
      IF (NREC.GT. LASTRC) GO TO 500
      IF (ICODE.NE.1) GO TO 300
      IF (USING) WRITE (7,820) LALOUT,MNTH,IDOOUT,SALTAB
      FORMAT (3A4,13,1X,A4,12(1X,A4))

      DO 120 I=1,12
        SALTAB(I) = BLANK
      USING = .FALSE.
      IF (MNTHIN.NE. MONTH) GO TO 100
      USING = .TRUE.
      LALOUT(1) = LALOIN(1)
      LALOUT(2) = LALOIN(2)
      LALOUT(3) = LALOIN(3)
      IDOUT = IDIN
      GO TO 100

C
C
C
C
300
      IF (.NOT. USING) GO TO 100
      IF (ICODE.NE. 3 .AND. ICODE .NE. 4 .AND. ICODE .NE. 6) GO TO 100
      DO 320 I=1,12
        IF (DEPTH.EQ. STDDEP(I)) GO TO 340
      CONTINUE
      GO TO 100
      SALTAB(I) = SAL
      GO TO 100

C
C
C
320
340
C
C
C

```

```

NOD000050
NOD000070
NOD000080
NOD000090
NOD00100
NOD00110
NOD00120
NOD00130
NOD00140
NOD00150
NOD00160
NOD00170
NOD00180
NOD00190
NOD00200
NOD00210
NOD00220
NOD00230
NOD00240
NOD00250
NOD00260
NOD00270
NOD00280
NOD00290
NOD00300
NOD00310
NOD00320
NOD00330
NOD00340
NOD00350
NOD00360
NOD00370
NOD00380
NOD00390
NOD00400
NOD00410
NOD00420
NOD00430
NOD00440
NOD00450
NOD00460
NOD00470
NOD00480
NOD00490
NOD00500
NOD00510
NOD00520

```



```

500 WRITE (6,830)
830 FORMAT (' END OF DATA ')
STOP
900 WRITE (6,840)
840 FORMAT (' READ PROBLEM ')
STOP
END
//GO.FT04F001.DD UNIT=3400-4,VOL=SER=NP S688,DISP=(OLD,KEEP),
//DCB=(DEN=2,RECFM=FB,LRECL=80,BLKSIZE=3200),LABEL=(1,SL,1N),
//DSN=S2514.NDC2
//GO.SYSIN DD *

```

```

NOD000530
NOD000540
NOD000550
NOD000560
NOD000570
NOD000580
NOD000590

```


NOD000010
 NOD000020
 NOD000030
 NOD000040
 NOD000050
 NOD000060
 NOD000070
 NOD000080
 NOD000090
 NOD000100
 NOD000110
 NOD000120
 NOD000130
 NOD000140
 NOD000150
 NOD000160
 NOD000170
 NOD000180
 NOD000190
 NOD000200
 NOD000210
 NOD000220
 NOD000230
 NOD000240
 NOD000250
 NOD000260
 NOD000270
 NOD000280
 NOD000290
 NOD000300
 NOD000310
 NOD000320
 NOD000330
 NOD000340
 NOD000350
 NOD000360
 NOD000370
 NOD000380
 NOD000390
 NOD000400
 NOD000410
 NOD000420
 NOD000430
 NOD000440
 NOD000010
 NOD000020
 NOD000030

*****NODPUNC*****

SOURCE: A.J. PICKRELL/D.W. YEAGER
SEPTEMBER 1978

THIS PROGRAM IS BASICALLY THE SAME PROGRAM AS NODPUNA.
 IT IS DESIGNED TO READ A STANDARD NODC MAGNETIC TAPE OF
 THE STATION DATA FILE TYPE AND PUNCH DATA CARDS CONTAINING
 THE FOLLOWING INFORMATION: LATITUDE OF STATION, LONGITUDE OF
 STATION, MONTH OF OBSERVATION, NODC IDENTIFICATION CODE, AND
 TEMPERATURE OBSERVED AT EACH STANDARD DEPTH FROM 0 TO 400 METERS.
 TEMPS. ARE PUNCHED IN DEG. CENTIGRADE TO HUNDRETHS
 OF A DEG.. NO DECIMAL POINT IS INSERTED BY THIS PROGRAM.
 CARDS ARE DESIGNED AS INPUT TO TEMDAT, DECIMAL POINT POSITION
 IS MADE BY TEMDAT.

EACH CARD CONTAINS ALL THE ABOVE INFORMATION FOR ONE OCEANOGRAPH-
 IC STATION.

PUNCH CARD FORMAT IS: (3A4,I3,I1X,A4,I2(I1X,A4))

USE OF NODPUNC IS EXACTLY LIKE NODPUNA: STATIONS ARE ABSTRACTED
 BY MONTH OF OBSERVATION. THREE INPUT CARDS MUST BE SPECIFIED:
 IFIRST=XXXXXX
 LASTRC=XXXXXX
 MONTH= XX

IFIRST IS FIRST RECORD NUMBER OF INTEREST ON MAGNETIC TAPE
 (THIS VALUE OBTAINED AFTER EXAMINING OUTPUT OF NODCDUM)
 AND LASTRC IS RECORD NUMBER OF LAST STATION OF INTEREST.
 MONTH (AS BEFORE) IS MONTH OF OBSERVATION DESIRED.

AFTER THESE INPUT VARIABLES HAVE BEEN SPECIFIED, THE PROGRAM
 WILL IGNORE ALL RECORDS PRIOR TO IFIRST. IT WILL THEN READ
 AND PUNCH DATA CARDS FOR ALL STATIONS OBSERVED DURING THE MONTH
 SPECIFIED BETWEEN IFIRST AND LASTRC.

DIMENSION LALOIN(3),LALOUT(3),TEMTAB(12),STDDEP(12)
 LOGICAL USING
 DATA BLANK/0/,STCDEP/0000,0010,0020,0030,
 *0050,0075,0100,0150,0200,0250,0300,0400/
 /

CALL REREAD	N0D000050
MONTH = 12	N0D000070
IFIRST = 85700	N0D000080
LASTRC = 90865	N0D000090
REWIND 4	N0D000100
NREC = 1	N0D000110
READ (4,800,END=900,ERR=900)	N0D000120
FORMAT(79X,I1)	N0D000130
IF (NREC .GE. IFIRST) GO TO 90	N0D000140
NREC=NREC+1	N0D000150
GO TO 20	N0D000160
C	N0D000170
C	N0D000180
90	N0D000190
100	N0D000200
810	N0D000210
	N0D000220
	N0D000230
	N0D000240
	N0D000250
	N0D000260
	N0D000270
	N0D000280
	N0D000290
	N0D000300
	N0D000310
	N0D000320
	N0D000330
	N0D000340
	N0D000350
	N0D000360
	N0D000370
	N0D000380
	N0D000390
	N0D000400
	N0D000410
	N0D000420
	N0D000430
	N0D000440
	N0D000450
	N0D000460
	N0D000470
	N0D000480
	N0D000490
	N0D000500
	N0D000510
	N0D000520


```

20      CALL REREAD
      MONTH = 12
      IFIRST = 85700
      LASTRC = 90865
      REWIND 4
      NREC = 1
      READ (4,800,END=900,ERR=900)
      FORMAT(79X,I1)
      IF (NREC .GE. IFIRST) GO TO 90
      NREC=NREC+1
      GO TO 20

C
C
90
100
810

      USING = .FALSE.
      READ (4,810,END=900,ERR=900) LALOIN,MNTHIN,DEPTH,TEM, IDIN, ICODE
      FORMAT(4X,2A4,A3,5X,I2,5X,A4,1X,A4,39X,A4,I1)
      NREC=NREC+1
      IF (NREC .GT. LASTRC) GO TO 500
      IF (ICODE .NE. 1) GO TO 300
      IF (USING) WRITE (7,820) LALOUT,MONTH, IDOUT, TEMTAB
      FORMAT (3A4,I3,1X,A4,I2(1X,A4))

      DO 120 I=1,12
      TEMTAB(I) = BLANK
      USING = .FALSE.
      IF (MNTHIN.NE. MONTH) GO TO 100
      USING = .TRUE.
      LALOUT(1) = LALOIN(1)
      LALOUT(2) = LALOIN(2)
      LALOUT(3) = LALOIN(3)
      IDOUT = IDIN
      GO TO 100

C
C
C
C
C
300

      IF (.NOT. USING) GO TO 100
      IF (ICODE.NE. 3 .AND. ICODE .NE. 4 .AND. ICODE .NE. 6) GO TO 100
      DO 320 I=1,12
      IF (DEPTH .EQ. STDDEP(I)) GO TO 340
      CONTINUE
      GO TO 100
      TEMTAB(I) = TEM
      GO TO 100

C
C
C
320
340
C
C
C

```



```

500 WRITE (6,830)
830 FORMAT (' END OF DATA')
STOP
900 WRITE (6,840)
840 FORMAT (' READ PROBLEM')
STOP
END
//GO .FT04F001 DD UNIT=3400-4, VOL=SER=NPS688, DISP=(CLD,KEEP),
// DCB=(DEN=2, RECFM=FB, LRECL=80, BLKSIZE=3200), LABEL=(1,SL,,IN),
// DSN=S2514.NDC2
//GO.SY SIN DD *
```

```

NOD000530
NOD000540
NOD000550
NOD000560
NOD000570
NOD000580
NOD000590
```


VEL00010
 VEL00020
 VEL00030
 VEL00040
 VEL00050
 VEL00060
 VEL00070
 VEL00080
 VEL00090
 VEL00100
 VEL00110
 VEL00120
 VEL00130
 VEL00140
 VEL00150
 VEL00160
 VEL00170
 VEL00180
 VEL00190
 VEL00200
 VEL00210
 VEL00220
 VEL00230
 VEL00240
 VEL00250
 VEL00260
 VEL00270
 VEL00280
 VEL00290
 VEL00300
 VEL00310
 VEL00320
 VEL00330
 VEL00340
 VEL00350
 VEL00360
 VEL00370
 VEL00380
 VEL00390
 VEL00400
 VEL00410
 VEL00420
 VEL00430
 VEL00440
 VEL00450
 VEL00460
 VEL00470
 VEL00480

***** VELDAT *****

SOURCE: A.J. PICKRELL/D.W. YEAGER
NOVEMBER 1978

THIS PROGRAM IS DESIGNED TO READ A SET OF DATA CARDS FOR OCEANO-
 GRAPHIC STATIONS CONTAINING SOUND SPEED DATA AT STANDARD DEPTHS
 (0 TO 400 METERS) FOR EACH STATION AND COMPUTE THE MEAN SOUND
 SPEED AT THE STANDARD DEPTHS FOR THE SET OF STATIONS SUBMITTED.
 PROGRAM ALSO COMPUTES STANDARD DEVIATION (ONE-SIGMA) OF
 SOUND SPEEDS AT EACH STANDARD DEPTH AND PRINTS THIS INFORMATION.
 IN ADDITION, LATITUDE AND LONGITUDE OF STATION HAVING THE
 MAXIMUM SOUND SPEED VALUE AND THE LATITUDE - LONGITUDE OF
 THE STATION HAVING THE MINIMUM SOUND SPEED VALUE AT EACH
 STANDARD DEPTH IS PRINTED.

DATA CARDS ARE GENERATED USING NODPUNA AND CONTAIN LATITUDE,
 LONGITUDE OF STATION, MONTH OF OBSERVATION, STATION NUMBER, AND
 LAST 4 DIGITS OF SOUND SPEED VALUE AT EACH STANDARD DEPTH
 FROM 0 TO 400 METERS.

NOTE: SOUND SPEED VALUE OF 1544.4 METERS/SEC WILL
 APPEAR ON CARD PRODUCED BY NODPUNA AS 5444. VELDAT
 ASSUMES THE VALUE OF 1000 M/SEC IS TO BE ADDED
 TO ALL SOUND SPEED VALUES ON DATA CARDS.

INPUT CARDS ARE READ IN THE FOLLOWING FORMAT:

(I2,F3.1,I3,F3.1,I4,I4,A4,I2(IX,F4.1))
 PLACEMENT OF THE DECIMAL POINT IS ACCOMPLISHED BY INPUT
 READ FORMAT.

STATION INPUT MAY BE GROUPED BY MONTH OR OTHER COMBINATION
 SUCH AS SEASON. IF GROUPED BY MONTH, EACH MONTH'S DATA
 CARDS MUST HAVE A CARD WITH 99 IN COL. 14 AND 15 AS LAST
 CARD OF MONTH GROUP. OTHER COMBINATIONS ARE SIMILAR, FOR
 EXAMPLE: INPUT CARDS FOR MONTHS 1,2,3 GROUPED TOGETHER
 AS AN INTER, A CARD WITH 99 IN COL. 14 AND 15 IS INSERTED AS
 LAST CARD IN GROUP., AND PRIOR TO NEXT GROUP.

PROGRAM MUST BE MODIFIED TO ACCEPT MORE THAN 150 STATIONS
 PER GROUP. ARRAYS LATDEG,RLATMN,LONDEG,RLONMN,ID, AND SV

C
C
C
C
C

MUST BE DIMENSIONED ACCORDING TO MAXIMUM INPUT CARDS IN A
GROUP.
INCREMENT IN FIRST "DO" LOOP MUST BE EXTENDED ACCORDINGLY.

```

DIMENSION IDEPTH(12), SVMEAN(12), STDDEV(12), NSMPLS(12),
* SVMAX(12), SVMIN(12), MAXLAD(12), RMXLAM(12), MAXLOD(12),
* RMXLOM(12), MINLAD(12), RMNLAM(12), MINLOD(12), RMNLOM(12),
* IDMAX(12), IDMIN(12)
DIMENSION LATDEG(150), RLATMN(150), LONDEG(150), RLONMN(150),
* ID(150), SV(150,12)
DATA IDEPTH/0,10,20,30,50,75,100,150,200,250,300,400/
DATA IBLANK / /
DO 690 MNTH = 1,12
DO 150 I = 1,150
READ (5,810) LATDEG(I), RLATMN(I), LONDEG(I), RLONMN(I), MONTH,
* ID(I), (SV(I,J), J=1,12)
FORMAT (12,F3.1,I3,F3.1,I4,1X,A4,12(1X,F4.1))
IF (MONTH .GT. 12) GO TO 190
DO 120 J = 1,12
IF (SV(I,J) .NE. 0.0) SV(I,J) = SV(I,J)+1000.0
CONTINUE

```

810
120
150
190
200

```

NSTA = I-1
DO 490 J = 1,12
SVMEAN(J) = 0.0
STDDEV(J) = 0.0
NSMPLS(J) = 0
SVMAX(J) = 0.0
SVMIN(J) = 1000000.0
MAXLAD(J) = 0
RMXLAM(J) = 0.0
MAXLOD(J) = 0
RMXLJM(J) = 0.0
MINLAD(J) = 0
RMNLAM(J) = 0.0
MINLOD(J) = 0
RMNLOM(J) = 0.0
IDMAX(J) = IBLANK
IDMIN(J) = IBLANK
DO 290 I = 1,NSTA
IF (SV(I,J) .EQ. 0.0) GO TO 290
NSMPLS(J) = NSMPLS(J)+1
SVMEAN(J) = SVMEAN(J) + SV(I,J)
IF (SV(I,J) .LT. SVMAX(J)) GO TO 250
SVMAX(J) = SV(I,J)
MAXLAD(J) = LATDEG(I)
RMXLAM(J) = RLATMN(I)

```

VEL000490
VEL000500
VEL000510
VEL000520
VEL000530
VEL000010
VEL000020
VEL000030
VEL000040

VEL000070
VEL000080
VEL000090

VEL000120
VEL000140
VEL000130
VEL000150
VEL000160
VEL000170
VEL000180
VEL000190
VEL000200
VEL000210
VEL000220
VEL000230
VEL000240
VEL000250
VEL000260
VEL000270
VEL000280
VEL000290
VEL000300
VEL000310
VEL000320
VEL000330
VEL000340
VEL000350
VEL000370
VEL000380
VEL000390

VEL000410
VEL000420
VEL000430
VEL000440

VEL00920
VEL00930
VEL00940
VEL00950

700 WRITE (6,860)
860 FORMAT ('END OF DATA')
STOP
END

VEL00010
 VEL00020
 VEL00040
 VEL00050
 VEL00060
 VEL00070
 VEL00080
 VEL00090
 VEL00100
 VEL00110
 VEL00120
 VEL00130
 VEL00140
 VEL00150
 VEL00160
 VEL00170
 VEL00180
 VEL00190
 VEL00200
 VEL00210
 VEL00220
 VEL00230
 VEL00240
 VEL00250
 VEL00260
 VEL00270
 VEL00280
 VEL00290
 VEL00300
 VEL00310
 VEL00320
 VEL00330
 VEL00340
 VEL00350
 VEL00360
 VEL00370
 VEL00380
 VEL00390
 VEL00400
 VEL00410
 VEL00420
 VEL00430
 VEL00440
 VEL00450
 VEL00460
 VEL00470
 VEL00480
 VEL00490

***** SALDAT *****

SOURCE: A.J. PICKRELL/D.W. YEAGER
NOVEMBER 1978

THIS PROGRAM IS DESIGNED TO READ A SET OF DATA CARDS FOR OCEANO-
 -GRAPHIC STATIONS CONTAINING SALINITY DATA AT STANDARD DEPTHS
 (0 TO 400 METERS) FOR EACH STATION AND COMPUTE THE MEAN
 SALINITY AT THE STANDARD DEPTHS FOR THE SET OF STATIONS SUBMITTED
 PROGRAM ALSO COMPUTES STANDARD DEVIATION (ONE-SIGMA) OF
 SALINITIES AT EACH STANDARD DEPTH AND PRINTS THIS INFORMATION.
 IN ADDITION, LATITUDE AND LONGITUDE OF STATION HAVING THE
 MAXIMUM SALINITY VALUE AND THE LATITUDE - LONGITUDE OF
 THE STATION HAVING THE MINIMUM SALINITY VALUE AT EACH
 STANDARD DEPTH IS PRINTED.

DATA CARDS ARE GENERATED USING NODPUNC AND CONTAIN LATITUDE,
 LONGITUDE OF STATION, MONTH OF OBSERVATION, STATION NUMBER, AND
 SALINITY VALUES (TO .01 PPT) AT EACH STANDARD DEPTH
 FROM 0 TO 400 METERS.

INPUT CARDS ARE READ IN THE FOLLOWING FORMAT:
 (I2,F3.1,I3,F3.1,I4,I4,A4,I2(IX,F5.2))
 PLACEMENT OF THE DECIMAL POINT IS ACCOMPLISHED BY INPUT
 READ FORMAT.

STATION INPUT MAY BE GROUPED BY MONTH OR OTHER COMBINATION
 SUCH AS SEASON. IF GROUPED BY MONTH, EACH MONTH'S DATA
 CARDS MUST HAVE A CARD WITH 99 IN COL. 14 AND 15 AS LAST
 CARD OF MONTH GROUP. OTHER COMBINATIONS ARE SIMILAR, FOR
 EXAMPLE: INPUT CARDS FOR MONTHS 1,2,3 GROUPED TOGETHER
 AS WINTER, A CARD WITH 99 IN COL. 14 AND 15 IS INSERTED AS
 LAST CARD IN GROUP., AND PRIOR TO NEXT GROUP.

PROGRAM MUST BE MODIFIED TO ACCEPT MORE THAN 150 STATIONS
 PER GROUP. ARRAYS LATDEG,RLATMN, LONDEG,RLONMN, ID, AND SV
 MUST BE DIMENSIONED ACCORDING TO MAXIMUM INPUT CARDS IN A
 GROUP.
 INCREMENT IN FIRST "DO" LOOP MUST BE EXTENDED ACCORDINGLY.


```

NOTE: ALTHOUGH THE PARAMETER BEING ANALYZED IS CHANGED,
THE VARIABLE NAMES IN THE PROGRAM HAVE NOT BEEN CHANGED
FROM VELDAT. ONLY INPUT FORMAT (READ FORMAT) HAS BEEN
CHANGED.

DIMENSION IDEPTH(12), SVMEAN(12), STDDEV(12), NSMPLS(12),
* SVMAX(12), SVMIN(12), MAXLAD(12), RMXLAM(12), MAXLOD(12),
* RMXLOM(12), MINLAD(12), RMNLAM(12), MINLOD(12),
* IDMAX(12), IDMIN(12)
DIMENSION LATDEG(150), RLATMN(150), LONDEG(150), RLONMN(150),
* ID(150), SV(150,12)
DATA IDEPTH/0,10,20,30,50,75,100,150,200,250,300,400/
DATA IBLANK/,1,12
DO 690 MNTH = 1,12
DO 150 I = 1,150
READ (5,810) LATDEG(I),RLATMN(I),LONDEG(I),RLONMN(I),MONTH,
* IC(I), (SV(I,J),J=1,12)
FORMAT (12,F3.1,13,F3.1,14,1X,A4,12(1X,F4.2))
IF(MONTH.GT.12) GO TO 190
DO 120 J = 1,12
IF(SV(I,J).NE. 0.0) SV(I,J) = SV(I,J)
CONTINUE
NSTA = I-1
DO 490 J = 1,12
SVMAX(J) = 0.0
SVMIN(J) = 1000000.0
MAXLAD(J) = 0
RMXLAM(J) = 0.0
MAXLOD(J) = 0
RMXLOM(J) = 0.0
MINLAD(J) = 0
RMNLAM(J) = 0.0
MINLOD(J) = 0
RMNLOM(J) = 0.0
IDMAX(J) = IBLANK
IDMIN(J) = IBLANK
DO 290 I = 1,NSTA
IF (SV(I,J).EQ. 0.0) GO TO 290
NSMPLS(J) = NSMPLS(J)+1
SVMEAN(J) = SVMEAN(J) + SV(I,J)
IF (SV(I,J).LT. SVMAX(J)) GO TO 250
SVMAX(J) = SV(I,J)
MAXLAD(J) = LATDEG(I)
RMXLAM(J) = RLATMN(I)

```


700
860

WRITE (6, 860)
FORMAT (' END OF DATA ')
STOP
END

VEL000920
VEL000930
VEL000940
VEL000950

VEL00020
VEL00030
VEL00040
VEL00050
VEL00060
VEL00070
VEL00080
VEL00090
VEL00100
VEL00110
VEL00120
VEL00130
VEL00140
VEL00150
VEL00160
VEL00170
VEL00180
VEL00190
VEL00200
VEL00210
VEL00220
VEL00230
VEL00240
VEL00250
VEL00260
VEL00270
VEL00280
VEL00290
VEL00300
VEL00310
VEL00320
VEL00330
VEL00340
VEL00350
VEL00360
VEL00370
VEL00380
VEL00390
VEL00400
VEL00410
VEL00420
VEL00430
VEL00440
VEL00450
VEL00460
VEL00470
VEL00480
VEL00490

SOURCE: A. J. PICKRELL/D.W. YFAGER
NOVEMBER 1978

THIS PROGRAM IS DESIGNED TO READ A SET OF DATA CARDS FOR OCEANO-
GRAPHIC STATIONS CONTAINING TEMPERATURE DATA AT STANDARD DEPTHS
(0 TO 400 METERS) FOR EACH STATION AND COMPUTE THE MEAN TEM-
PERATURE AT THE STANDARD DEPTHS FOR THE SET OF STATIONS SUBMITTED
PROGRAM ALSO COMPUTES STANDARD DEVIATION (ONE-SIGMA) OF
TEMPERATURES AT EACH STANDARD DEPTH AND PRINTS THIS INFORMATION.
IN ADDITION, LATITUDE AND LONGITUDE OF STATION HAVING THE
MAXIMUM TEMPERATURE VALUE AND THE LATITUDE - LONGITUDE OF
THE STATION HAVING THE MINIMUM TEMPERATURE VALUE AT EACH
STANDARD DEPTH IS PRINTED.

DATA CARDS ARE GENERATED USING NODPUNB AND CONTAIN LATITUDE, LONGITUDE OF STATION, MONTH OF OBSERVATION, STATION NUMBER, AND TEMPERATURE VALUES (TO .01 DEG-C) AT EACH STANDARD DEPTH FROM 0 TO 400 METERS.

INPUT CARDS ARE READ IN THE FOLLOWING FORMAT:
(I2,F3.1,I3,F3.1,I4,IX,A4,I2(IX,F5.2))
PLACEMENT OF THE DECIMAL POINT IS ACCOMPLISHED BY INPUT
READ FORMAT.

STATION INPUT MAY BE GROUPED BY MONTH OR OTHER COMBINATION SUCH AS SEASON. IF GROUPED BY MONTH, EACH MONTH'S DATA CARDS MUST HAVE A CARD WITH 99 IN COL. 14 AND 15 AS LAST CARD OF MONTH GROUP. OTHER COMBINATIONS ARE SIMILAR, FOR EXAMPLE: INPUT CARDS FOR MONTHS 1, 2, 3 GROUPED TOGETHER AS WINTER, A CARD WITH 99 IN COL. 14 AND 15 IS INSERTED AS LAST CARD, IN GROUP, AND PRIOR TO NEXT GROUP.

PROGRAM MUST BE MODIFIED TO ACCEPT MORE THAN 150 STATIONS PER GROUP. ARRAYS LATDEG,RLATMN,LONDEG,RLOMN,ID, AND SV MUST BE DIMENSIONED ACCORDING TO MAXIMUM INPUT CARDS IN A GROUP.

100

C
C
C
C
C

NOTE: ALTHOUGH TH PARAMETER BEING ANALYZED IS CHANGED,
THE VARIABLE NAMES IN THE PROGRAM HAVE NOT BEEN CHANGED
FROM VELDAT. ONLY INPUT FORMAT (READ FORMAT) HAS BEEN
CHANGED.

```

DIMENSION IDEPTH(12), SVMEAN(12), STDEVI(12), NSMPLS(12),
* SVMAX(12), SVMIN(12), MAXLAD(12), RMXLAM(12), MAXLOD(12),
* RMXLAM(12), MINLAD(12), RMNLAM(12), MINLOD(12), RMNLAM(12),
* IDMAX(12), IDMIN(12)
DIMENSION LATDEG(150), RLATMN(150), LONDEG(150), RLONMN(150),
* ID(150), SV(150,12)
DATA IDEPTH/0,10,20,30,50,75,100,150,200,250,300,400/
DATA IRLANK / ,'/
DO 690 MNTH = 1,12
DO 150 I = 1,150
READ (5,810) LATDEG(I), RLATMN(I), LONDEG(I), RLONMN(I), MONTH,
* ID(I), (SV(I,J), J=1,12)
IF (MONTH .GT. 12) GO TO 190
FORMAT (12,F3.1,13,F3.1,14,1X,A4,12(1X,F4.2))
DO 120 J = 1,12
IF (SV(I,J) .NE. 0.0) SV(I,J) = SV(I,J)
CONTINUE

```

810

120
150
190
200

```

NSTA = I-1
DO 490 J = 1,12
SVMEAN(J) = 0.0
STDEVI(J) = 0.0
NSMPLS(J) = 0
SVMAX(J) = 0.0
SVMIN(J) = 1000000.0
MAXLAD(J) = 0
RMXLAM(J) = 0.0
MAXLOD(J) = 0
RMXLAM(J) = 0.0
MINLAD(J) = 0
RMNLAM(J) = 0.0
MINLOD(J) = 0
RMNLAM(J) = 0.0
IDMAX(J) = IRLANK
IDMIN(J) = IRLANK
DO 290 I = 1, NSTA
IF (SV(I,J) .EQ. 0.0) GO TO 290
NSMPLS(J) = NSMPLS(J)+1
SVMEAN(J) = SVMEAN(J) + SV(I,J)
IF (SV(I,J) .LT. SVMAX(J)) GO TO 250
SVMAX(J) = SV(I,J)
MAXLAD(J) = LATDEG(I)
RMXLAM(J) = RLATMN(I)

```

VEL00500
VEL00510
VEL00520
VEL00530
VEL00010
VEL00010
VEL00010
VEL00020
VEL00030
VEL00040

VEL00070
VEL00080
VEL00090

VEL00110
VEL00120
VEL00130
VEL00140
VEL00150
VEL00160
VEL00170
VEL00180
VEL00190
VEL00200
VEL00210
VEL00220
VEL00230
VEL00240
VEL00250
VEL00260
VEL00270
VEL00280
VEL00290
VEL00300
VEL00310
VEL00320
VEL00330
VEL00340
VEL00350
VEL00360
VEL00370
VEL00380
VEL00390
VEL00400
VEL00410
VEL00420
VEL00430


```

MAXLOD(J) = LONDEG(I)
RMXLAM(J) = RLONMN(I)
IDMAX(J) = ID(I)
IF(SV(I,J) .GT. SVMIN(J)) GO TO 290
SVMIN(J) = SV(I,J)
MINLAD(J) = LATDEG(I)
RMNLAM(J) = RLATMN(I)
MINLOD(J) = LONDEG(I)
RMNLAM(J) = RLONMN(I)
IDMIN(J) = ID(I)
CONTINUE
290 IF(NSMPLS(J) .LE. 1) GO TO 400
300 SVMEAN(J) = SVMEAN(J)/NSMPLS(J)
SUM = 0.0
DO 390 I = 1, NSTA
IF(SV(I,J) .EQ. 0.0) GO TO 390
SUM = SUM + (SV(I,J) - SVMEAN(J))**2
CONTINUE
STDDEV(J) = Sqrt(SUM/(NSMPLS(J)-1))
CONTINUE
400 CONTINUE
490 CONTINUE
500 WRITE(6,820) MNTH = 'I2)
820 WRITE(6,830)
FORMAT(10,1X,T13,MEAN
*/T5,DEPTH
*/T49,MAXIMUM
*/T91,MINIMUM
*/T6,MIN
*/T49,MAXIMUM
*/T80,MINIMUM
DO 550 J = 1,12
WRITE(6,840) IDEPTH(J),SVMEAN(J),STDDEV(J),NSMPLS(J),
*/SVMAX(J),SVMIN(J),MAXLAD(J),RMXLAM(J),MINLAD(J),RMNLAM(J),
*/IDMAX(J),IDMIN(J)
FORMAT(10,1X,T15,F6.2,T28,F6.2,T40,I3,T50,F6.2,
*/T60,F6.2,T69,I3,F5.1,T80,I3,F5.1,T92,A4,T102,A4)
WRITE(6,850) MAXLOD(J),RMXLAM(J),MINLOD(J),RMNLAM(J)
FORMAT(10,1X,T69,I3,F5.1,T80,I3,F5.1)
CONTINUE
850 CONTINUE
550 CONTINUE
CONTINUE
690 CONTINUE

```


700
860

WRITE (6,860)
FORMAT (' END OF DATA.')

STOP
END

VEL00920
VEL00930
VEL00940
VEL00950

Appendix 2:
VELDAT Results

WINTER - REGION II

DEPTH (M)	MEAN SOUND VELOCITY (M/SEC)	STANDARD DEVIATION (M/SEC)	NUMBER OF SAMPLES	MAXIMUM (M/SEC)	MINIMUM (M/SEC)	LOCATION OF MAX	LOCATION OF MIN	ID NUMB OF MAX	ID NUMB OF MIN
0	1521.5	5.4	39	1531.3	1507.7	32 7.8 79 5.0	32 5.3 79 32.4	61	49
10	1521.1	5.3	40	1529.6	1507.5	32 7.8 79 5.0	32 51.3 78 43.4	61	45
20	1521.3	4.9	37	1529.6	1508.0	32 7.8 79 5.0	32 5.3 79 32.4	61	49
30	1522.2	4.9	26	1528.8	1507.9	32 7.8 79 5.0	32 5.3 79 32.4	61	49
50	1521.6	4.5	19	1527.8	1510.4	32 7.8 79 5.0	32 20.0 79 0.0	61	42
75	1520.5	4.4	14	1526.6	1512.1	32 7.8 79 5.0	32 38.6 78 34.0	61	44
100	1517.9	5.7	7	1523.6	1507.7	32 9.1 79 3.2	32 7.8 79 6.0	29	60
150	1513.0	1.8	2	1514.3	1511.8	32 26.0 78 42.0	32 14.0 78 58.0	41	74
200	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
250	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
300	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
400	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		

SPRING - REGION II

DEPTH (M)	MEAN SOUND VELOCITY (M/SEC)	STANDARD DEVIATION (M/SEC)	NUMBER OF SAMPLES	MAXIMUM (M/SEC)	MINIMUM (M/SEC)	LOCATION OF MAX	LOCATION OF MIN	ID NUMB OF MAX	ID NUMB OF MIN
0	1524.0	4.2	31	1534.8	1514.5	32 33.0 78 34.0	32 28.0 79 36.0	59	2
10	1523.9	4.1	28	1534.7	1514.1	32 33.0 78 34.0	32 28.0 79 36.0	59	2
20	1523.6	3.6	25	1531.7	1518.2	32 33.0 78 34.0	32 40.0 79 0.0	59	47
30	1523.7	4.1	21	1535.7	1517.9	32 13.0 79 2.0	32 19.0 79 9.0	595	56
50	1521.4	2.8	10	1526.7	1517.9	32 13.0 79 2.0	32 11.0 79 10.0	595	55
75	1518.7	2.6	8	1522.8	1515.4	32 55.0 78 8.0	32 2.0 79 14.0	70	54
100	1514.4	3.2	5	1519.1	1511.3	32 38.0 78 30.0	32 13.0 79 2.0	99	595
150	1516.5	0.0	1	1516.5	1516.5	32 38.0 78 30.0	32 36.0 78 30.0	99	99
200	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
250	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
300	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
400	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		

SUMMER - REGION II

DEPTH (M)	MEAN SOUND VELOCITY (M/SEC)	STANDARD DEVIATION (M/SEC)	NUMBER OF SAMPLES	MAXIMUM (M/SEC)	MINIMUM (M/SEC)	LOCATION OF MAX	LOCATION OF MIN	ID NUMB OF MAX	ID NUMB OF MIN
0	1541.7	1.7	77	1545.4	1536.0	32 7.6 79 31.9	32 14.0 79 7.0	35	2
10	1541.0	1.8	78	1544.4	1533.4	32 30.0 79 0.0	32 14.0 79 7.0	4	2
20	1538.8	3.3	67	1544.2	1523.8	32 34.6 78 38.8	32 14.0 79 7.0	23	2
30	1534.6	5.4	48	1540.4	1516.4	32 13.0 79 9.2	32 14.0 79 7.0	31	2
50	1530.2	6.0	25	1538.0	1514.4	32 3.2 79 23.5	32 14.0 79 7.0	86	2
75	1523.6	7.0	10	1534.0	1512.0	32 12.2 79 0.8	32 24.0 78 45.0	11	45
100	1515.6	11.1	6	1531.2	1499.1	32 12.2 79 0.8	32 24.0 78 45.0	11	45
150	1499.3	10.8	4	1508.4	1484.4	32 26.0 78 43.0	32 24.0 78 45.0	48	45
200	1494.2	14.4	2	1504.4	1484.0	32 26.0 78 43.0	32 24.0 78 45.0	48	45
250	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
300	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
400	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		

AUTUMN - REGION II

DEPTH (M)	MEAN SOUND VELOCITY (M/SEC)	STANDARD DEVIATION (M/SEC)	NUMBER OF SAMPLES	MAXIMUM (M/SEC)	MINIMUM (M/SEC)	LOCATION OF MAX	LOCATION OF MIN	ID NUMB OF MAX	ID NUMB OF MIN
0	1533.9	4.5	33	1540.0	1523.3	32 37.0 78 32.0	32 12.0 79 33.0	64	39
10	1534.0	4.4	33	1539.6	1523.5	32 13.0 79 9.0	32 12.0 79 33.0	57	39
20	1533.8	4.5	33	1539.5	1523.2	32 13.0 79 9.0	32 40.0 79 0.0	57	43
30	1535.1	3.3	18	1539.6	1528.5	32 13.0 79 9.0	32 12.7 79 10.8	57	57
50	1536.5	3.0	6	1538.9	1530.7	32 29.0 78 48.0	32 10.0 79 7.0	63	32
75	1533.2	7.5	5	1537.8	1519.9	32 12.0 79 6.0	32 10.0 79 7.0	60	32
100	1527.8	13.8	3	1537.3	1512.0	32 25.0 78 44.0	32 10.0 79 7.0	47	32
150	1512.7	5.8	2	1516.8	1508.6	32 25.0 78 44.0	32 10.0 79 7.0	47	32
200	1505.7	0.0	1	1505.7	1505.7	32 10.0 79 7.0	32 10.0 79 7.0	32	32
250	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
300	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
400	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		

WINTER - REGION II

DEPTH (M)	MEAN TEMP. (DEG-C)	STANDARD DEVIATION (DEG-C)	NUMBER OF SAMPLES	MAXIMUM (DEG-C)	MINIMUM (DEG-C)	LOCATION OF MAX	LOCATION OF MIN	ID NUMB OF MAX	ID NUMB OF MIN
0	19.24	1.89	40	22.91	14.71	32 7.8 79 5.0	32 51.3 78 43.4	61	45
10	19.05	1.84	40	22.17	14.53	32 7.8 79 5.0	32 51.3 78 43.4	61	45
20	19.14	1.70	38	22.09	14.69	32 7.8 79 5.0	32 5.3 79 32.4	61	49
30	19.35	1.69	26	21.72	14.60	32 7.8 79 5.0	32 5.3 79 32.4	61	49
50	19.01	1.53	19	21.19	15.31	32 7.8 79 5.0	32 20.0 79 0.0	61	42
75	18.26	1.69	15	20.57	15.06	32 7.8 79 5.0	32 20.0 79 0.0	61	42
100	17.46	1.81	7	19.34	14.23	32 9.1 79 3.2	32 7.8 79 6.0	29	60
150	15.57	0.56	2	15.97	15.18	32 26.0 78 42.0	32 14.0 78 58.0	41	74
200	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
250	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
300	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
400	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		

SPRING - REGION II

DEPTH (M)	MEAN TEMP. (DEG-C)	STANDARD DEVIATION (DEG-C)	NUMBER OF SAMPLES	MAXIMUM (DEG-C)	MINIMUM (DEG-C)	LOCATION OF MAX	LOCATION OF MIN	ID NUMB OF MAX	ID NUMB OF MIN
0	20.63	1.72	33	24.86	17.30	32 13.0 79 2.0	32 28.0 79 36.0	595	2
10	20.49	1.75	30	25.16	17.12	32 13.0 79 2.0	32 28.0 79 36.0	595	2
20	20.15	1.71	26	25.47	18.06	32 13.0 79 2.0	32 40.0 79 0.0	595	47
30	19.90	1.56	21	24.62	17.86	32 13.0 79 2.0	32 19.0 79 9.0	595	56
50	18.90	1.03	10	20.90	17.68	32 13.0 79 2.0	32 11.0 79 10.0	595	55
75	17.81	0.87	8	19.21	16.73	32 55.0 78 8.0	32 2.0 74 14.0	70	54
100	16.25	0.97	5	17.70	15.32	32 38.0 78 30.0	32 13.0 79 2.0	99	595
150	16.56	0.0	1	16.56	16.56	32 38.0 78 30.0	32 38.0 78 30.0	99	99
200	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
250	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
300	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
400	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		

SUMMER - REGION II

DEPTH (M)	MEAN TEMP. (DEG-C)	STANDARD DEVIATION (DEG-C)	NUMBER OF SAMPLES	MAXIMUM (DEG-C)	MINIMUM (DEG-C)	LOCATION OF MAX	LOCATION OF MIN	ID NUMB OF MAX	ID NUMB OF MIN
0	27.74	0.78	78	29.32	25.01	32 7.6 79 31.9	32 14.0 79 7.0	35	2
10	27.32	0.84	78	28.70	23.79	32 30.0 79 0.0	32 14.0 79 7.0	4	2
20	26.16	1.39	68	28.50	20.00	32 34.6 78 38.8	32 14.0 79 7.0	23	2
30	24.23	2.19	48	26.81	17.37	32 0.5 79 17.0	32 14.0 79 7.0	22	2
50	22.31	2.31	25	25.43	16.57	32 3.2 79 23.5	32 14.0 79 7.0	86	2
75	19.69	2.45	10	23.40	15.76	32 12.2 79 0.8	32 24.0 78 45.0	11	45
100	16.94	3.58	6	22.06	11.82	32 12.2 79 0.8	32 24.0 78 45.0	11	45
150	11.76	2.91	4	14.27	7.76	22 26.0 78 43.0	32 24.0 78 45.0	48	45
200	10.15	3.83	2	12.86	7.45	22 26.0 78 43.0	32 24.0 78 45.0	48	45
250	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
300	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
400	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		

AUTUMN - REGION II

DEPTH (M)	MEAN TEMP. (DEG-C)	STANDARD DEVIATION (DEG-C)	NUMBER OF SAMPLES	MAXIMUM (DEG-C)	MINIMUM (DEG-C)	LOCATION OF MAX	LOCATION OF MIN	ID NUMB OF MAX	ID NUMB OF MIN
0	24.09	1.81	33	26.50	19.84	32 37.0 78 32.0	32 12.0 79 33.0	64	39
10	24.03	1.78	33	26.41	19.87	32 13.0 79 9.0	32 12.0 79 33.0	57	39
20	23.90	1.84	33	26.29	19.67	32 13.0 79 9.0	32 40.0 79 0.0	57	43
30	24.32	1.35	18	26.25	21.65	32 13.0 79 9.0	32 12.7 79 10.8	57	57
50	24.73	1.20	6	25.71	22.46	32 29.0 78 48.0	32 10.0 79 7.0	63	32
75	23.29	2.84	5	25.08	18.31	32 12.0 79 6.0	32 10.0 79 7.0	60	32
100	21.17	4.91	3	24.70	15.56	32 25.0 78 44.0	32 10.0 79 7.0	47	32
150	15.50	1.73	2	16.73	14.28	32 25.0 78 44.0	32 10.0 79 7.0	47	32
200	13.21	0.0	1	13.21	13.21	32 10.0 79 7.0	32 10.0 79 7.0	32	32
250	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
300	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
400	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		

WINTER - REGION II

DEPTH (M)	MEAN SALINITY (PPT)	STANDARD DEVIATION (PPT)	NUMBER OF SAMPLES	MAXIMUM (PPT)	MINIMUM (PPT)	LOCATION OF MAX	LOCATION OF MIN	ID NUMB OF MAX	ID NJMB OF MIN
0	36.29	0.10	39	36.47	36.01	32 22.0 79 15.0	32 5.3 79 32.4	1	49
10	36.28	0.10	40	36.46	36.01	32 22.0 79 15.0	32 5.3 79 32.4	1	49
20	36.24	0.32	38	36.45	34.43	32 22.0 79 15.0	32 12.1 79 11.2	1	2
30	36.28	0.12	26	36.44	36.02	32 12.1 79 11.2	32 5.3 79 32.4	2	49
50	36.29	0.14	19	36.55	36.02	32 7.4 79 5.9	32 20.0 79 0.0	3	42
75	36.27	0.14	14	36.46	36.00	32 7.4 79 5.9	32 14.0 78 58.0	3	74
100	36.24	0.20	7	36.42	35.88	32 9.1 79 3.2	32 7.8 79 6.0	29	60
150	36.12	0.04	2	36.15	36.09	32 26.0 78 42.0	32 14.0 78 58.0	41	74
200	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
250	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
300	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
400	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		

SPRING - REGION II

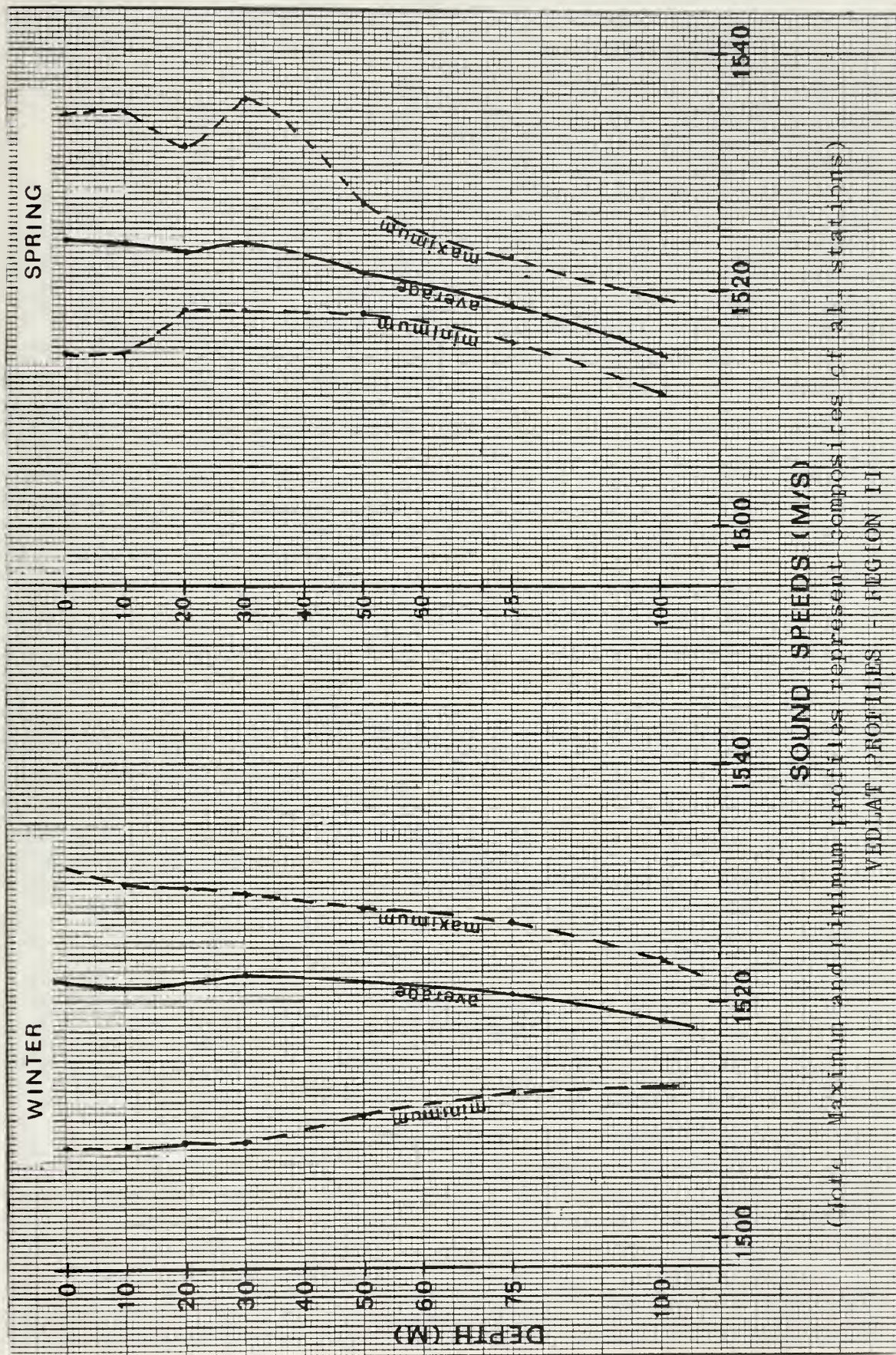
DEPTH (M)	MEAN SALINITY (PPT)	STANDARD DEVIATION (PPT)	NUMBER OF SAMPLES	MAXIMUM (PPT)	MINIMUM (PPT)	LOCATION OF MAX	LOCATION OF MIN	ID NUMB OF MAX	ID NUMB OF MIN
0	35.72	0.77	32	36.63	33.87	32 46.0 78 30.0	32 35.0 79 27.0	98	597
10	35.86	0.61	28	36.63	34.39	32 46.0 78 30.0	32 35.0 79 27.0	98	597
20	36.14	0.23	25	36.62	35.67	32 46.0 78 30.0	32 24.0 79 15.0	98	556
30	36.22	0.21	21	36.62	35.69	32 46.0 78 30.0	32 24.0 79 15.0	98	596
50	36.29	0.15	10	36.54	36.09	32 38.0 78 30.0	32 20.0 78 58.0	99	94
75	36.28	0.18	8	36.52	35.99	32 38.0 78 30.0	32 20.0 78 58.0	99	94
100	36.19	0.29	5	36.51	35.88	32 38.0 78 30.0	32 20.0 78 58.0	99	94
150	36.49	0.0	1	36.49	36.49	32 38.0 78 30.0	32 38.0 78 30.0	99	99
200	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
250	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
300	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
400	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		

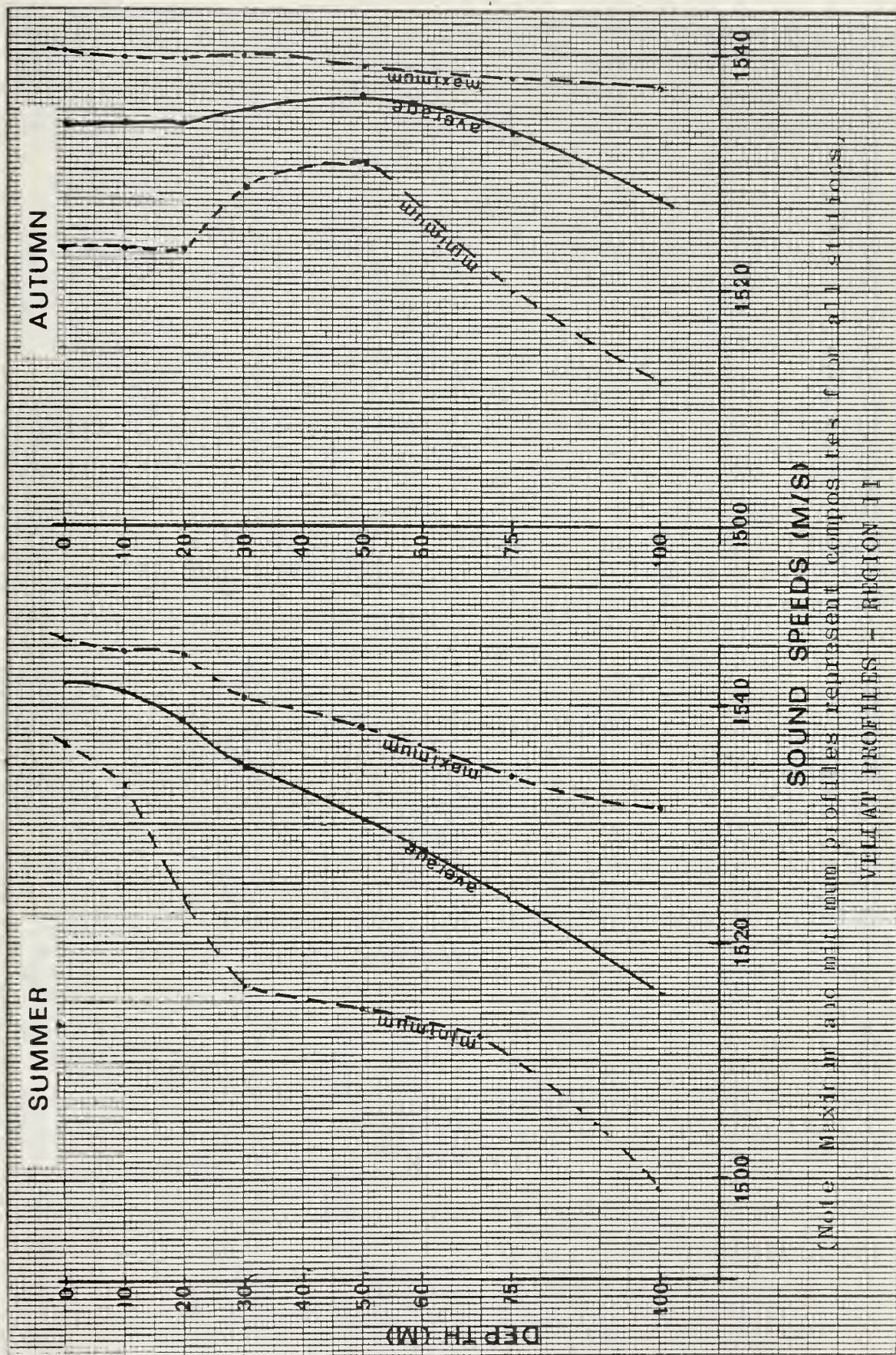
SUMMER - REGION II

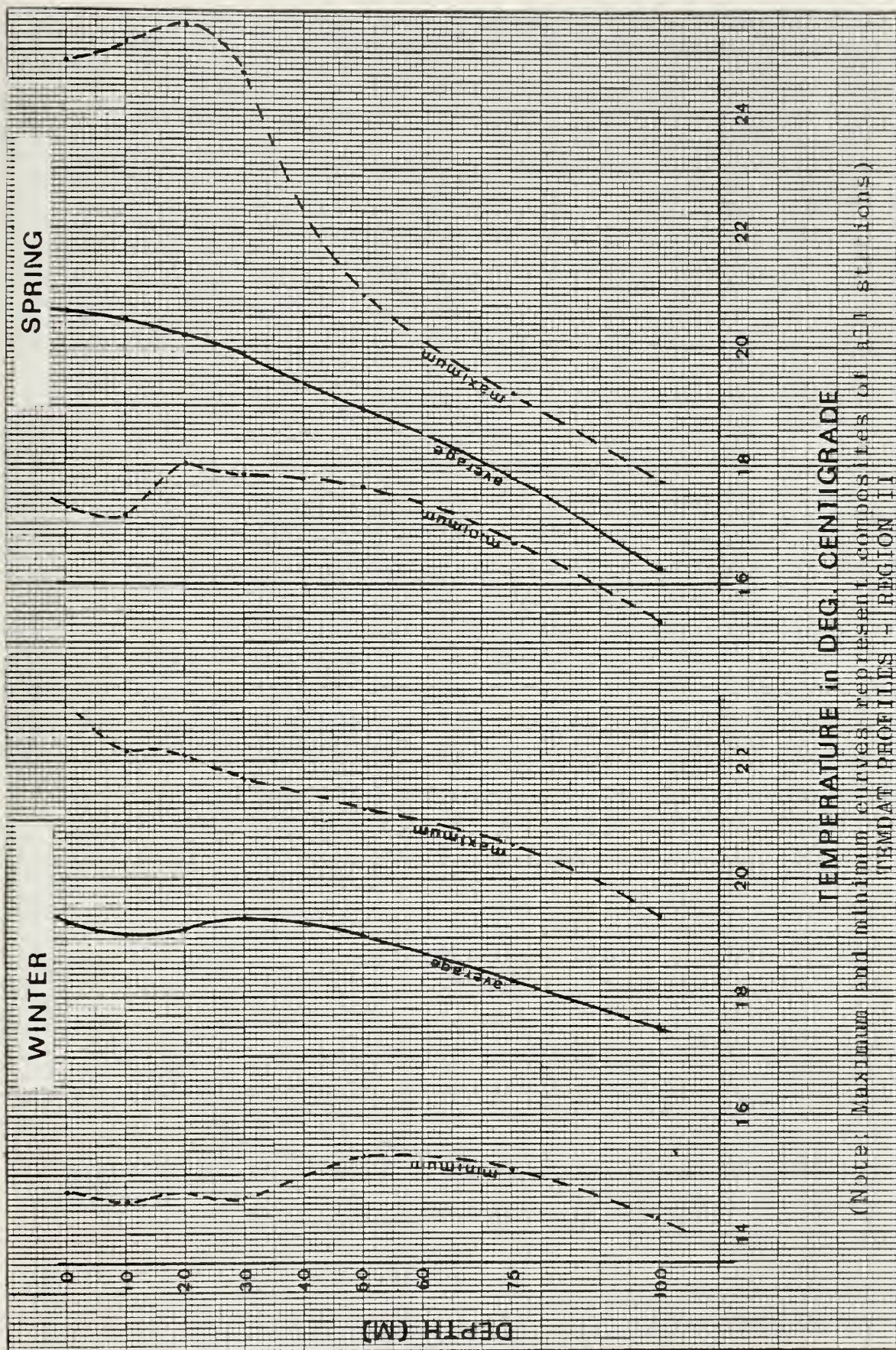
DEPTH (M)	MEAN SALINITY (PPT)	STANDARD DEVIATION (PPT)	NUMBER OF SAMPLES	MAXIMUM (PPT)	MINIMUM (PPT)	LOCATION OF MAX	LOCATION OF MIN	ID NUMB OF MAX	ID NUMB OF MIN
0	35.60	0.53	77	36.58	33.08	32 26.0 78 43.0	32 30.0 79 10.0	48	8
10	35.68	0.48	78	36.42	33.36	32 12.2 79 0.8	32 30.0 79 10.0	11	8
20	35.92	0.32	67	36.45	34.43	32 12.2 79 0.8	32 30.0 79 10.0	11	8
30	36.12	0.21	48	36.48	35.45	32 12.2 79 0.8	32 9.5 79 30.1	11	23
50	36.18	0.21	25	36.54	35.55	32 12.2 79 0.8	32 13.2 79 0.0	11	90
75	36.09	0.38	10	36.63	35.42	32 8.7 79 10.5	32 13.2 79 0.0	12	90
100	35.87	0.50	6	36.70	35.29	32 12.2 79 0.8	32 13.2 79 0.0	11	90
150	35.44	0.35	4	35.71	34.97	32 26.0 78 43.0	32 24.0 78 45.0	48	45
200	35.28	0.47	2	35.62	34.95	32 26.0 78 43.0	32 24.0 78 45.0	48	45
250	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
300	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
400	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		

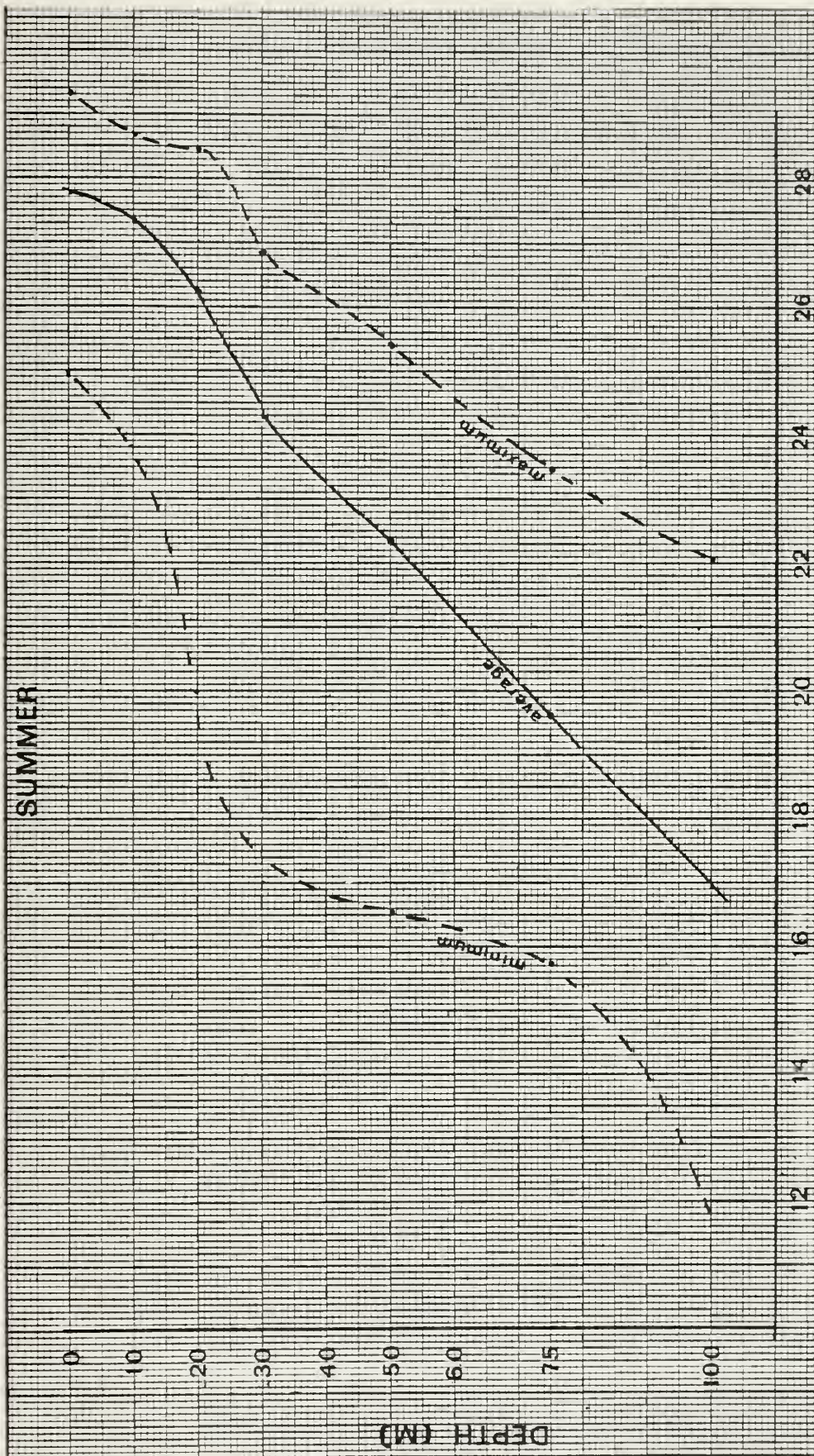
AUTUMN - REGION II

DEPTH (M)	MEAN SALINITY (PPT)	STANDARD DEVIATION (PPT)	NUMBER OF SAMPLES	MAXIMUM (PPT)	MINIMUM (PPT)	LOCATION OF MAX	LOCATION OF MIN	ID NUMB OF MAX	ID NUMB OF MIN
0	36.25	0.17	33	36.52	35.46	32 37.0 78 32.0	32 49.0 78 44.0	64	67
10	36.25	0.13	33	36.54	35.81	32 37.0 78 32.0	32 49.0 78 44.0	64	67
20	36.26	0.10	33	36.55	36.09	32 37.0 78 32.0	32 22.0 79 14.0	64	29
30	36.26	0.12	18	36.57	36.11	32 37.0 78 32.0	32 10.0 79 7.0	64	32
50	36.34	0.18	6	36.60	36.09	32 37.0 78 32.0	32 10.0 79 7.0	64	32
75	36.35	0.21	5	36.64	36.05	32 37.0 78 32.0	32 10.0 79 7.0	64	32
100	36.36	0.34	3	36.67	36.00	32 37.0 78 32.0	32 10.0 79 7.0	64	32
150	36.09	0.34	2	36.33	35.85	32 25.0 78 44.0	32 10.0 79 7.0	47	32
200	35.69	0.0	1	35.69	35.69	32 10.0 79 7.0	32 10.0 79 7.0	32	32
250	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
300	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		
400	0.0	0.0	0	0.0	*****	0 0.0 0 0.0	0 0.0 0 0.0		

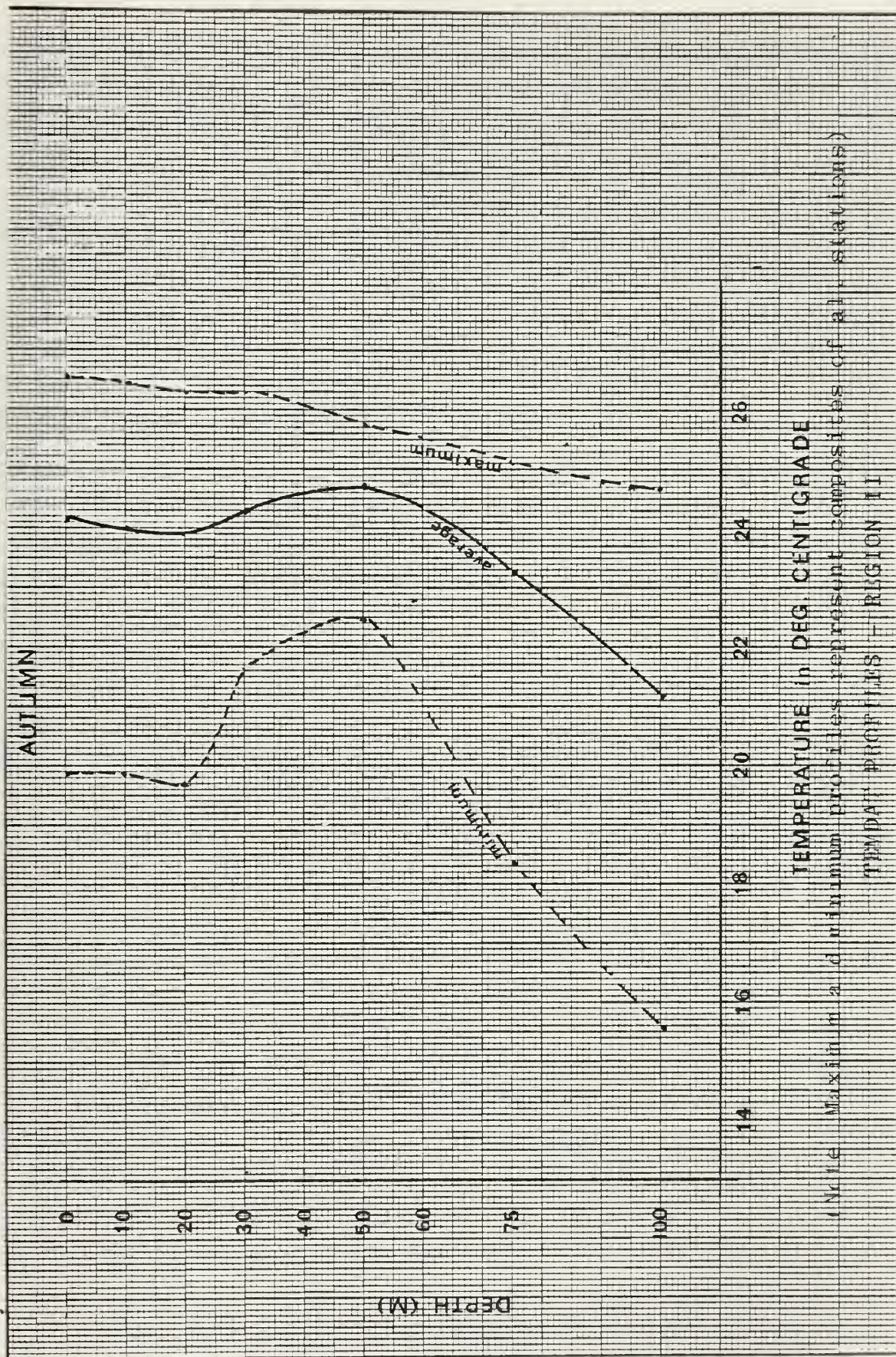


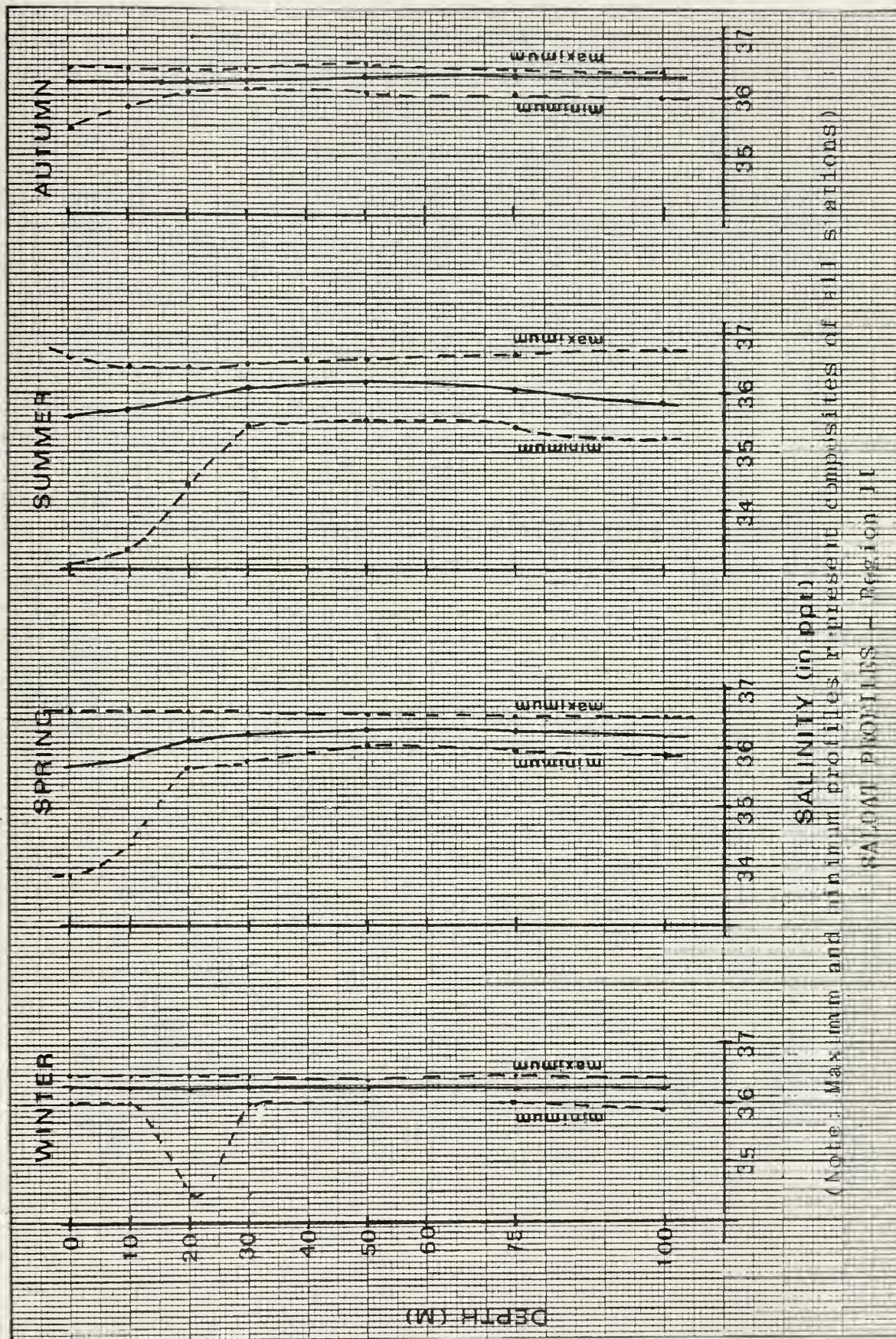






TEMPERATURE in DEG. CENTIGRADE
 (Note: Maximum in ---, Minimum in ---, Average in —) — Profiles represent composites of all stations)
TEMPERATURE PROFILES - REGION #1



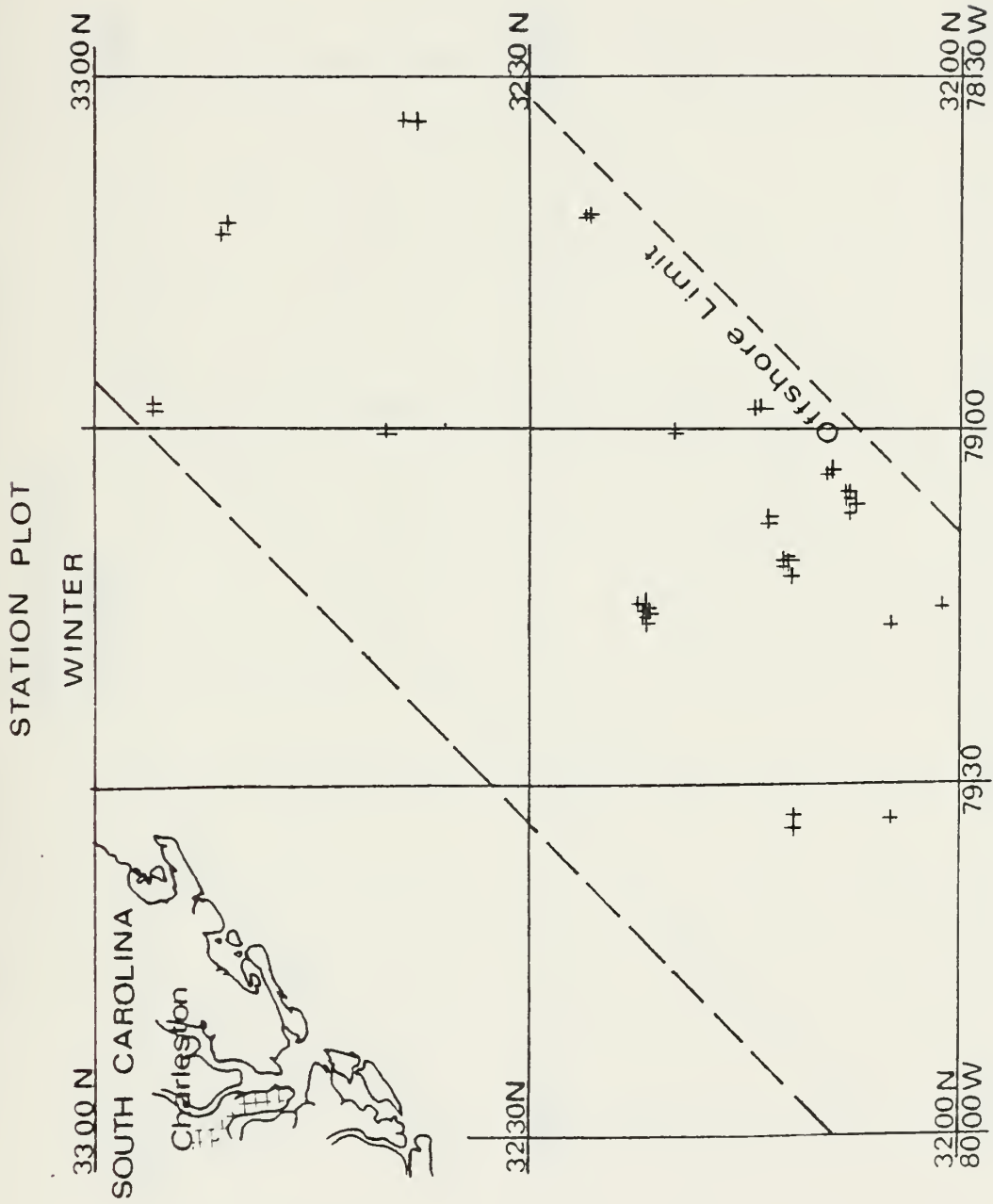


SALINITY (in ppt)

(Note: Maximum and minimum profiles represent composites of all stations)

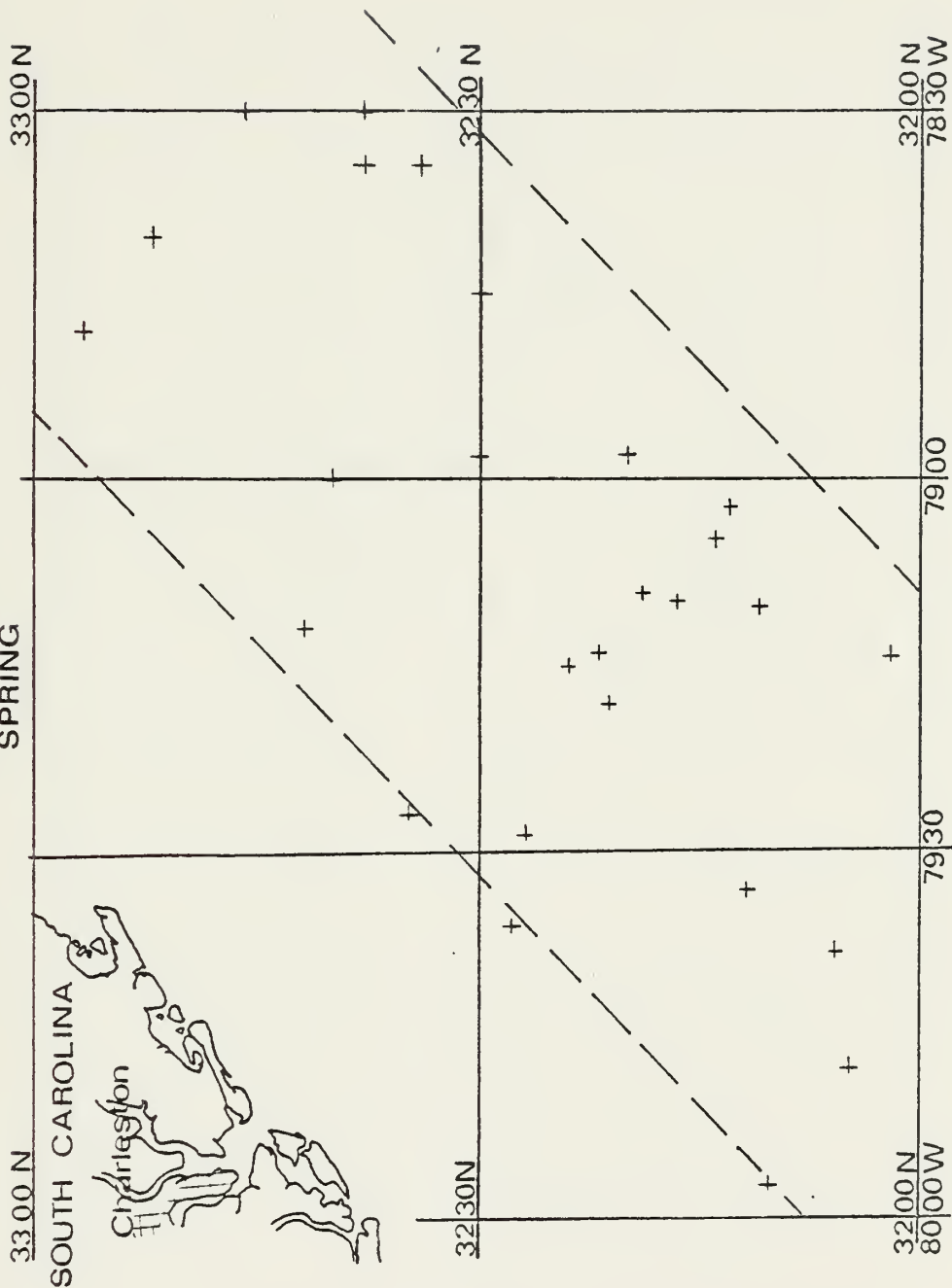
SALINITY PROFILES - Region II

Appendix 3:
Station Location Plots



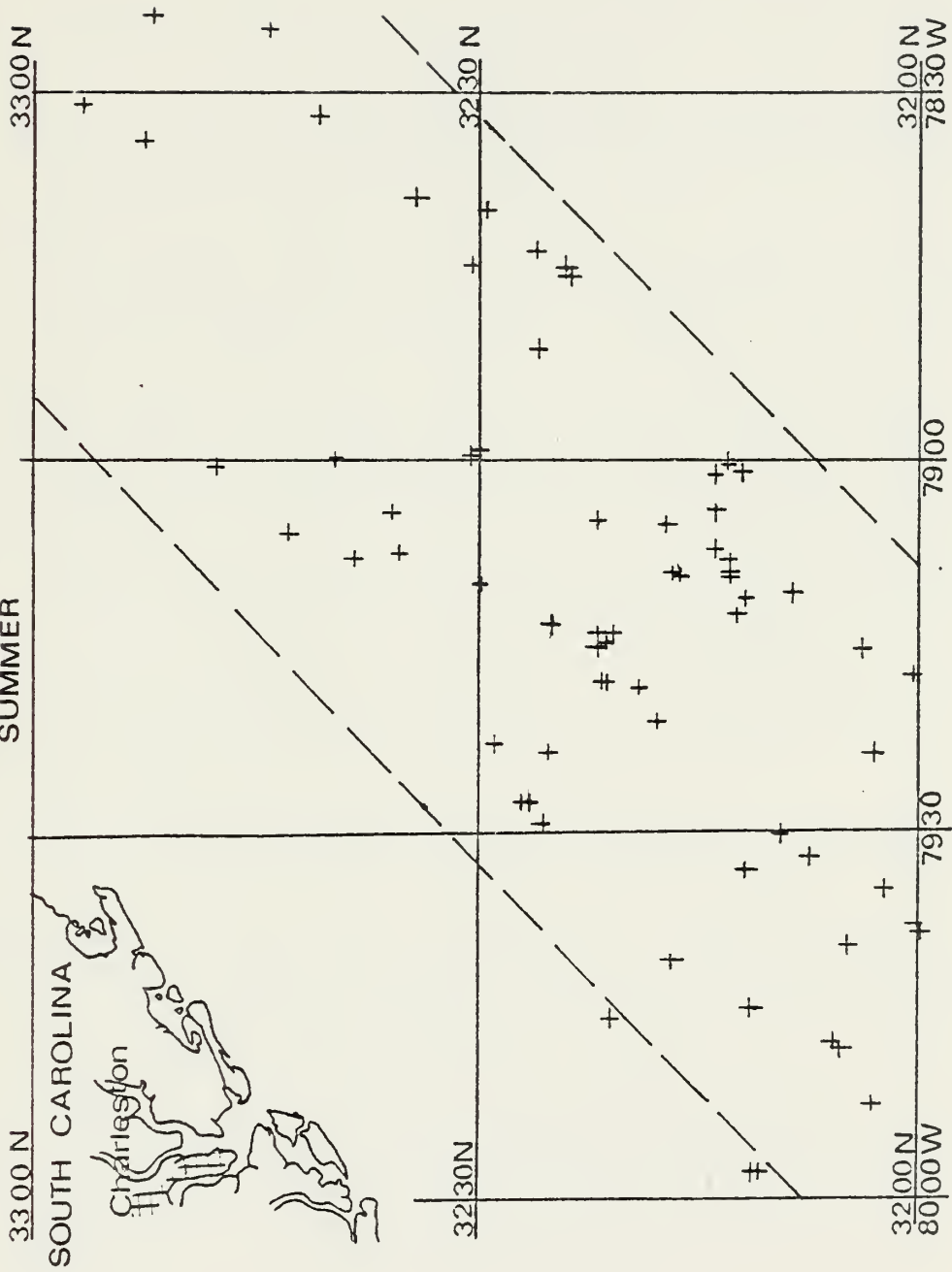
STATION PLOT

SPRING



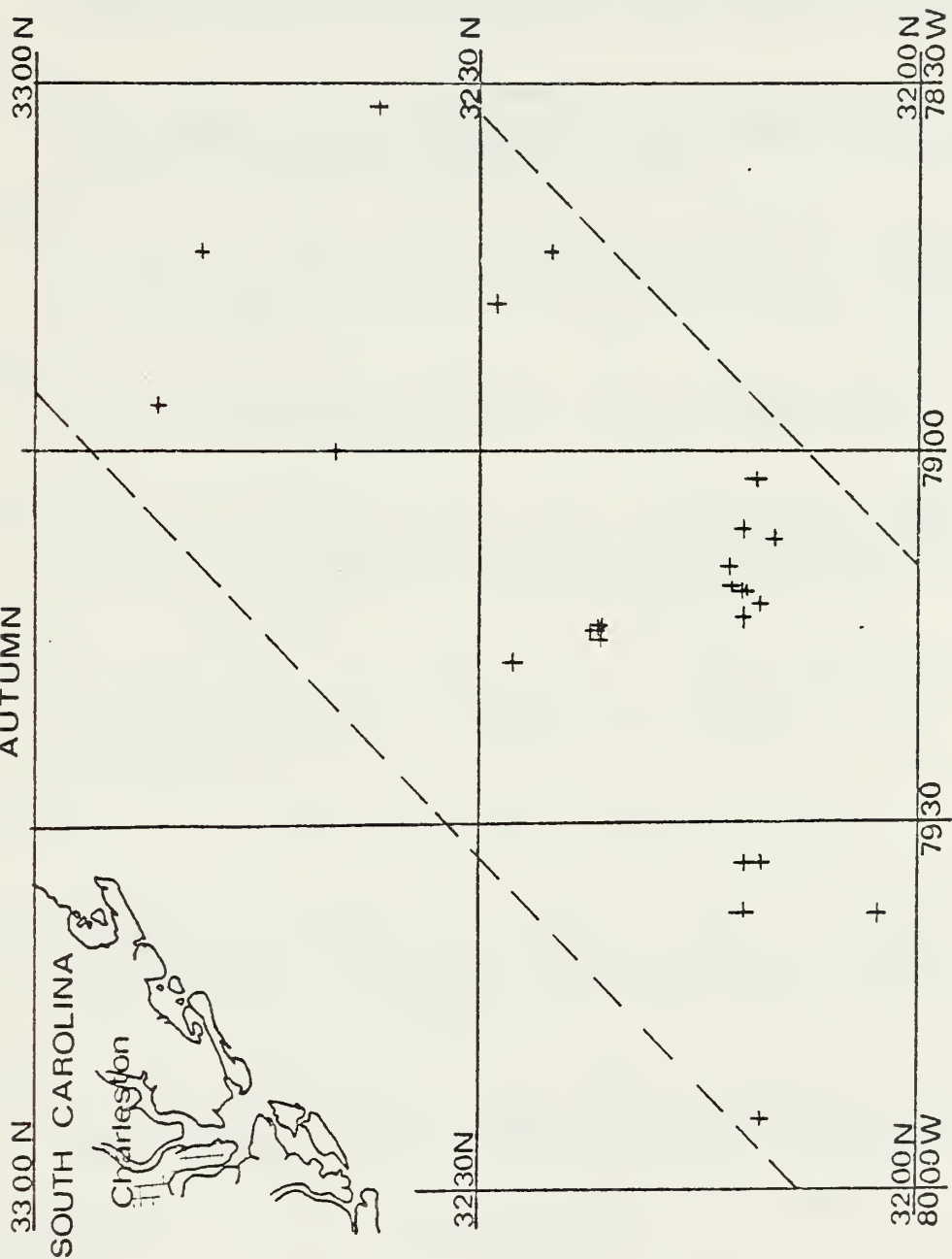
STATION PLOT

SUMMER



STATION PLOT

AUTUMN



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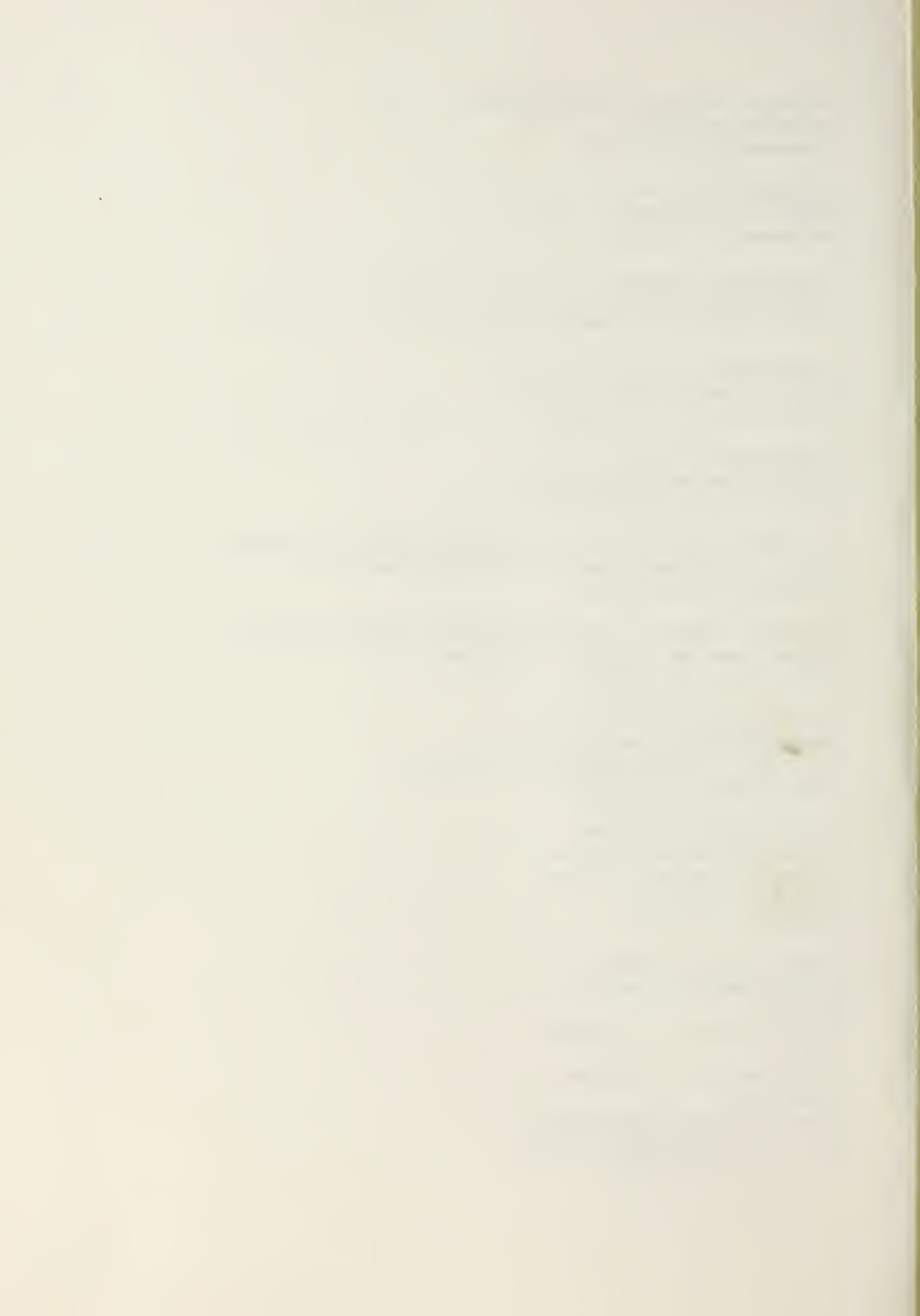
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